

R E P O R T R E S U M E S

ED 003 534

56

AN INVESTIGATION OF THE IMPROVEMENT OF EDUCATIONAL FILMSTRIPS
AND A DERIVATION OF PRINCIPLES RELATING TO THE EFFECTIVENESS
OF THESE MEDIA--STUDY II.

BY- VANDERMEER, A.W.

PENNSYLVANIA STATE UNIV., UNIVERSITY PARK

REPORT NUMBER NDEA-VIIA-224-11

PUB DATE

64

GRANT OEG-736049

EDRS PRICE MF-\$0.27 HC-\$6.16 154P.

DESCRIPTORS- *INSTRUCTIONAL FILMS, *INSTRUCTIONAL IMPROVEMENT,
*FILM PRODUCTION, *LEARNING EXPERIENCE, GEOGRAPHY
INSTRUCTION, COMPARATIVE ANALYSIS, *TEACHING TECHNIQUES,
UNIVERSITY PARK, PENNSYLVANIA

IN A PREVIOUS STUDY, REPORTED IN ED 003 533, THE
FILMSTRIP, "THE SUN AND ITS PLANETS," WAS FIELD TESTED AND
REVISED. THIS PROVIDED THE BASIS FOR A SECOND REVISION WHICH
WAS COMPARED WITH THE ORIGINAL. THE TWO VERSIONS WERE
PRESENTED TO RANDOMLY SELECTED HALVES OF THREE GROUPS OF
STUDENTS. THESE STUDENTS WERE SELECTED FROM GRADES 5, 6, 7,
AND 10. THE PRESENTATIONS CONSISTED OF PROJECTING THE
FILMSTRIP, AND READING THE LABELS AND CAPTIONS ALOUD. A
MULTIPLE-CHOICE TEST WAS GIVEN ON THE CONTENT OF THE FILM.
THE RESULTS INDICATED THAT ALL THE SUBJECTS EXCEPT THOSE IN
THE 10TH GRADE EARNED SIGNIFICANTLY HIGHER SCORES THAN THOSE
WHO VIEWED THE ORIGINAL FILMSTRIP. LEARNER RESPONSES
INDICATED SIGNIFICANT DIFFERENCES TO TEST ITEMS IN FAVOR OF
THE REVISED FILMSTRIP. IT WAS CONCLUDED THAT THE TEACHING
POTENTIAL CAN BE INCREASED BY USING FILMSTRIPS. PHASE THREE
OF THIS STUDY WAS ASSIGNED ACCESSION NUMBER ED 003 535. (RS)

ED003534

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
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II

**AN INVESTIGATION OF THE IMPROVEMENT OF
EDUCATIONAL FILMSTRIPS AND A DERIVATION OF
PRINCIPLES RELATING TO THE EFFECTIVENESS
OF THESE MEDIA** , PHASE 2, REV OR

PHASE II REVISION OF
FILM STRIP—THE SUN AND ITS PLANETS

U.S. Office of Education Grant No. 736049

A. W. VanderMeer

College of Education
The Pennsylvania State University
University Park
Pennsylvania

The research reported herein was supported through Title VII of the National Defense Education Act of 1958 (P.L. 85-864) administered by the Educational Media Branch of the Office of Education, U. S. Department of Health, Education and Welfare.

ERRATA

(Filmstrip Study Phase II)

page 27

Frame 5 of the revised filmstrip is erroneously printed in the report as a negative: i.e., the lettering in the revised filmstrip was white on black as in the original, and it should have been printed in this way in the report. Also, definition was much better in the filmstrip than in the report.

page 71

Frame 19 was erroneously printed at the top of the page instead of at the bottom, and Frame 18 was printed at the bottom instead of at the top.

A. W. VanderMeer

An Investigation of the Improvement
of Informational Filmstrips and the Deviation
of Principles Related to the Improvement of
these Media: Study II

A. W. VanderMeer
Professor of Secondary Education
The Pennsylvania State University
University Park, Pennsylvania

ACKNOWLEDGMENTS

The study reported herein was supported in part by grant number 225 of Title VII of the National Defense Education Act. Additional support was provided by The Pennsylvania State University.

In addition to the principal investigator, a number of individuals and groups contributed time and effort to the conduct of the study. Their cooperation, encouragement and work are gratefully acknowledged. Robert Montgomery served as an able assistant throughout the study, and Philip Smith and Howard Thorn also contributed time and energy to the completion of the work.

Mr. Jack Kennan, President of the Society for Visual Education and his staff were diligent and cooperative in preparing the revision of the experimental filmstrip, *The Sun and Its Planets*. Rosemary James and Marjorie Ziobro performed clerical and secretarial duties connected with the research, and Una Mae Livingston prepared numerous statistical tables.

Teachers and pupils of grades 5, 6, 7, and 10 of the Captain Jack High School, cooperated as experimental subjects and proctors, giving freely of their time and good will.

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CHAPTER I

Introduction, Overview, and Summary

Introduction: The filmstrip began to attain prominence as a teaching device as early as 1920. It was considered to be a convenient alternative to a set of lantern slides at first, but soon began to take the form of an organized illustrated presentation combining pictures, graphics and print in a unified, orderly sequence.

As the art of filmstrip production developed, the prominence and primacy of the pictorial element declined relatively as the importance of the caption and title frame increased. Presented in a manner in which the teacher read aloud titles and captions and added descriptive, attention directing or expository commentary as the filmstrip was projected, the filmstrip became the basic element of illustrated lectures in many classrooms.

Student learning from filmstrips has rarely approached the level that might theoretically be expected. To some extent, this may be a function of method of utilization, but to some extent the discrepancy between what the students learn from a filmstrip and the amount of information that is in the filmstrip is probably also attributable to deficiencies in the way the filmstrip was made. It was the thesis of this study that if an existing filmstrip could be remade in such a way that the students who were presented with

the original, certain principles might emerge that could be applied to the production of future filmstrips.

Overview: In a previous study¹, the filmstrip Sun and Its Planets had been field tested and revised on the basis of the tests. Some of the revisions proved effective in subsequent field tests, some produced no significant changes in the learning of groups of children, and a few actually proved to be inferior to the original. The experience of producing the first revision and field testing it provided the basis for a second revision. The second revision was compared with the original in a field testing situation, and the results are reported herein.

Summary: Original and revised filmstrips on the solar system were presented, respectively to randomly selected halves of three groups of students in grades 5 and 6, 7 and 10. The filmstrip presentations consisted of projecting the filmstrip and reading the labels and captions aloud. At the conclusion a multiple choice test was given on the content of the filmstrip. Students in the fifth, sixth and seventh grades who saw the revised filmstrip earned mean scores that were statistically significantly higher than those who saw the original filmstrip. There were no significant differences in mean scores earned by tenth grade groups.

¹An Investigation of the Improvement of Informational Filmstrips and the Derivation of Principles related to the Improvement of these Media: Study I.

Thirty-five of the forty original filmstrip frames used were revised. There were significant differences in learner responses to test items based on twenty-one of these frames, in favor of the revised frame.

CHAPTER II

Conduct of the Research

The study reported herein is essentially a continuation of, but not a replication of, a previous study utilizing the same original filmstrip as an original starting point. The general procedure was to compare the responses of elementary and secondary school children to test items used as a measure of learning from the frames of the first revision of the original filmstrip, "Sun and Its Planets", with the responses to the same frames of the original filmstrip. As a result of this study, and as a result of general knowledge, insights, and guesses, a second revision of the original filmstrip was prepared in cooperation with the producer of the original filmstrip, the Society for Visual Education. This second revision was then compared with the original on the basis of responses to various items of a common test of information presented in both filmstrip versions.

403 students from grades five, six, seven and ten in the public schools of Mount Union, Pennsylvania participated in the research. The subjects were all members of regular classes in the elementary, junior high school, or senior high school. Mount Union is a small town in the center of a district in which the population is engaged in manufacturing, mining, agriculture, and in commercial enterprises supporting populations engaged in these occupations.

Students were selected for participation in the research on the basis of entire class groupings designated by the appropriate building principal.

Fig. A provides descriptive statistics on the characteristics of subjects used. It will be observed that the groups of subjects did not differ markedly with respect to age, intelligence quotient, or male - female ratio. Those slight differences that do exist would, on a priori basis, seem to favor the original filmstrip over the revised filmstrip; that is, there were slightly more females who saw the revised filmstrip than those who saw the original, and the largest difference in mean IQ - 2.5 IQ points - was in favor of the original filmstrip.

The experimental groups were constituted by assigning even numbered students in the teachers' grade books to the groups seeing the original filmstrip and odd numbered students to the groups seeing the revised filmstrip. In the case of fifth and sixth graders, in a given elementary school building one class of fifth graders and one of sixth graders of presumed approximately average ability were divided into halves by the procedure mentioned in the previous sentence. The odd numbered fifth graders would then join the odd numbered sixth graders in one classroom to view the original filmstrip and the even numbered fifth graders would be joined by the even numbered sixth graders in their classroom to view the revised filmstrip.

Seventh and tenth graders were randomly assigned to the original filmstrip group or to the revised filmstrip group in their homerooms, and then sent either to an auditorium or to a cafeteria

FIGURE A
CHARACTERISTICS OF SUBJECTS

	Grade	N	Male	Female	Age Range	Mean IQ
A. ORIGINAL FILMSTRIP GROUP	5,6	72	41	31	10-13	109.6
	7	72	37	35	12-14	100.8
	10	59	24	35	15-18	101.3
B. REVISED FILMSTRIP GROUP	5,6	68	33	35	10-13	107.1
	7	71	37	34	12-14	101.1
	10	61	22	39	14-18	101.5

and general purpose room for filmstrip presentations and for tests. The lighting conditions and acoustics were judged equally satisfactory in both rooms by the experimenters.

All filmstrip presentations were made and all tests were monitored by Mr. Robert Montgomery, an experienced teacher, with classroom and homeroom teachers serving as monitors.

On entering the rooms where the experiments were conducted, the subjects found a 35 millimeter filmstrip projector already set up and a screen of adequate size in place. Room darkening shades had been pulled prior to the entrance of the students.

The investigator introduced himself and explained that he had been given authorization to present a useful instructional filmstrip to the group. He stated further that following the filmstrip presentation a test would be given on the information presented by the filmstrip, and that the score earned by the students on this test would be reported to the science teacher of each individual student.

The filmstrip presentation consisted of projecting each successive frame on the screen and permitting it to remain there for approximately five seconds. At the conclusion of five seconds, the labels and captions were read. There followed an interval of approximately fifteen seconds for further study of the frame by the students. The specific directions to students and the introduction of the investigator may be found in Appendix A.

Following the presentation of the filmstrip, IBM answer sheets and electrographic pencils were passed to the students.

Next the test booklets were distributed. The standard IBM directions were read to the students and they were permitted to proceed with the test. All students were given as much time as necessary to complete the test.

The test was a fifty-seven item four choice multiple choice instrument which had been prepared basically as part of study number one. A few modifications were made in order to "visualize" certain test items where they had been completely verbal in the original test and a few items were added to provide a fuller coverage of material presented in the original and revised filmstrips.

Fig. B shows the Kuder Richardson Formula 22 reliabilities as computed for the test from data derived from the six groups seeing the original and revised filmstrips.

Tests were scored by machine. The IBM graphic item count was used to determine the number of students selecting each of the alternative responses in each of the test items in the achievement test. Mean scores, standard deviations, and critical ratios were computed on total test scores. Proportions of students selecting various alternative choices to specific items were derived from table of percentage. Significances of differences in proportions passing test items were computed.

The original filmstrip had been revised by cooperative action between the investigator and the personnel of the Society for Visual Education. In a production conference, the investigators sat down with the appropriate personnel of the Society for

FIGURE B

Reliability of Achievement Test

Number of Items	57	57	57	57	57	57
K	72	68	72	71	59	61
M	27.80	31.96	33.47	35.83	38.12	37.82
	7.42	7.06	6.37	7.00	7.81	9.24
Reliability	.70	.67	.57	.65	.79	.84

Visual Education and described in general terms how each frame should be revised. The Society for Visual Education contracted with an artist to produce the cells for the new frames. These cells were sent to the investigators for checking. In those cases where modifications in the revision seemed necessary, further exchange of information was undertaken. The final revision was completed in the studios of the Society for Visual Education on specifications agreed to by the investigators.

CHAPTER III

The Revisions and the Test Results

The first frame of both the revision and the original provided the information necessary to respond correctly to the following item:

1. Which of the following lines has in it the name of something that is not in our solar system?
 1. the sun, comets, meteors
 2. planets, moons, asteroids
 3. moons, constellations, the sun
 4. asteroids, planets, meteors

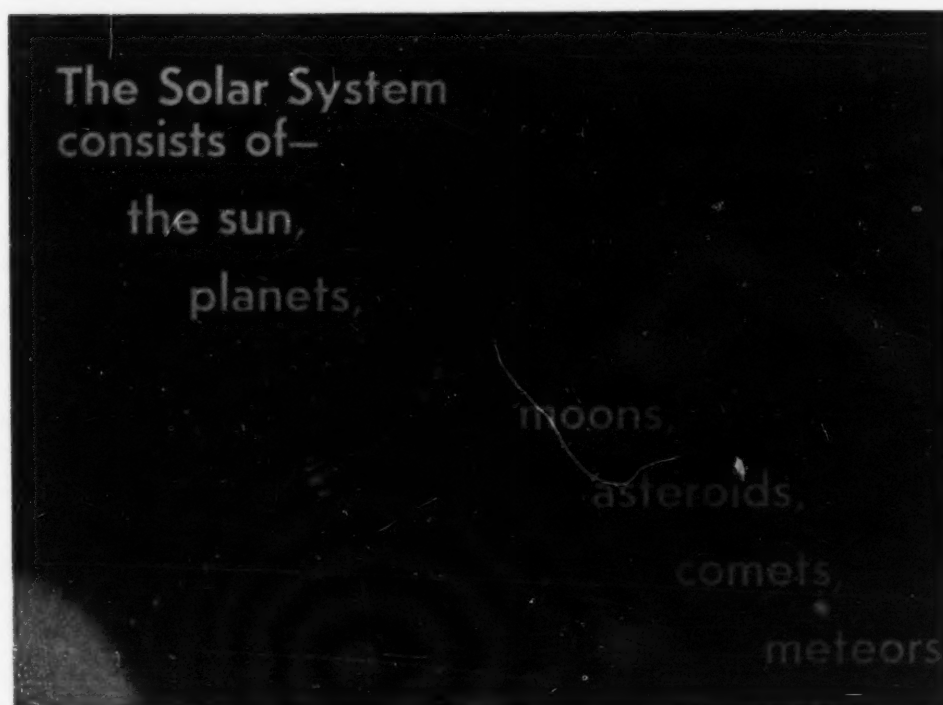
Obviously, the correct response required the students to recall that constellations do not appear in the solar system. It was hypothesized that labeling the various bodies that could be represented in the frame as part of the solar system would increase the likelihood that students would recognize the fact that constellations were not included. An examination of Table 1 reveals that the elementary grade pupils responded in the predicted way, but the difference was not statistically significant. Small non-significant differences were observed in favor of the original version with junior and senior high school populations.

Meteors were omitted from the revised version, but were included in the captions of the original version although nothing was shown in the drawing to represent them. If they recalled

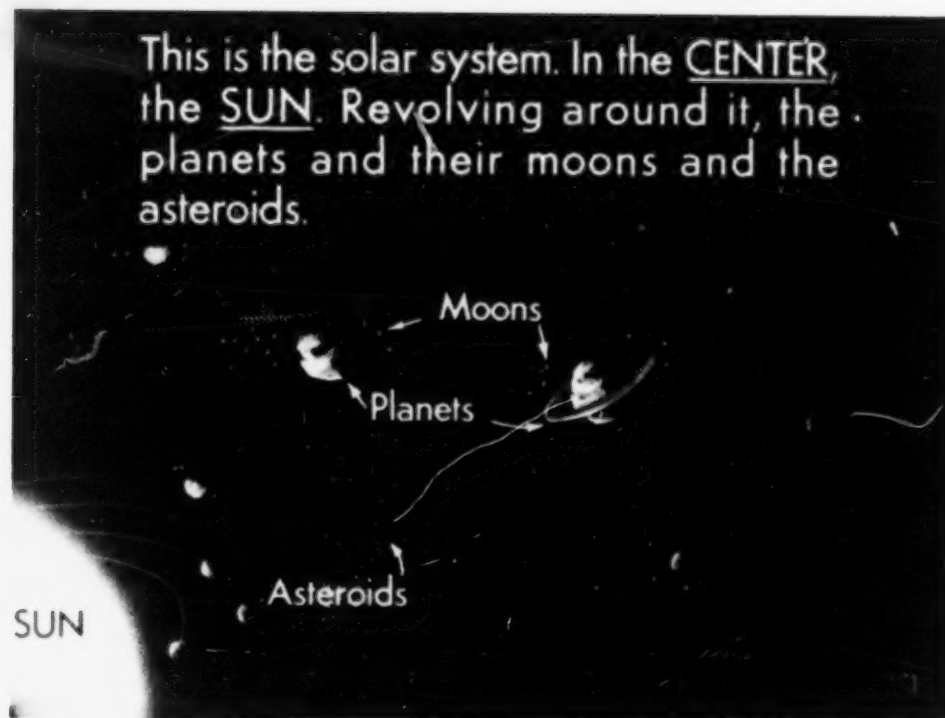
TABLE 1

Percent Choosing Various Responses to Item 1

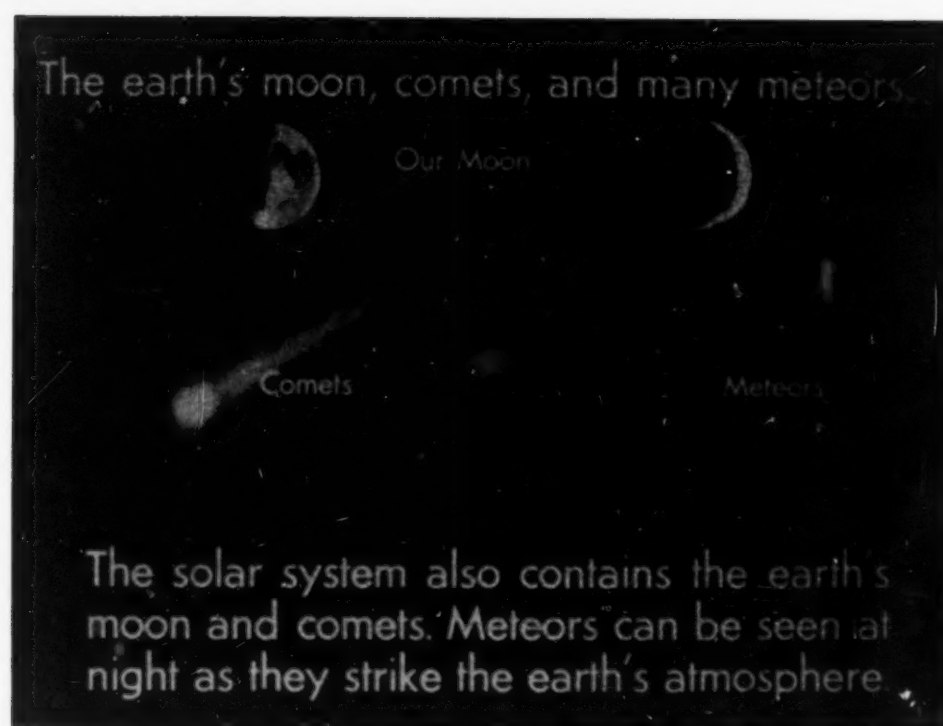
Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	19	9	7	9	2	3
2	7	4	4	1	0	8
3	59	74	86	76	91	87
4	15	13	3	14	7	2



Frame 1, Original



Frame 1, Revision



Frame 1A, Revision

only this one frame, therefore, the students seeing the revised version had to choose between two responses that might seem correct; that is, choices (3) and (4). Actually, however, there were no significant differences between the groups in the number choosing response number 4. The second frame of the revision, however, included meteors as part of the solar system.

Test item number 2 repeated below required the students to locate the sun relative to the rest of the solar system. The information that it is in the center was given in the first

2. The sun is a star. In what part of our solar system is it located?

1. northern part
2. southern part
3. center
4. outer part

frames of the revised filmstrip and repeated in the second, whereas the information was limited to the single second frame in the original. Furthermore, the information was emphasized in the revision by capitalizing and underlining the words "center" and "sun". In the revised drawing, also, an attempt was made to make those parts of the orbits that were shown appear to "go around" the sun.

Table 2 shows that a significantly greater proportion of grade school students seeing the revision passed the item, but there were no significant differences between the group at the secondary school level.

TABLE 2

Percent Choosing Various Responses to Item 2

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	0	6	0	0	0	0
2	6	3	4	4	3	2
3	68	84*	92	95	95	87
4	26	7*	4	1	2	11

*Significant at the .05 level.

The third test item required the student to identify phrases that correctly describe the character of the sun.

3. The sun is a huge globe of

1. solid coal that will burn forever
2. earth covered with hot lava
3. rock polished like nickel
4. glowing hot gases

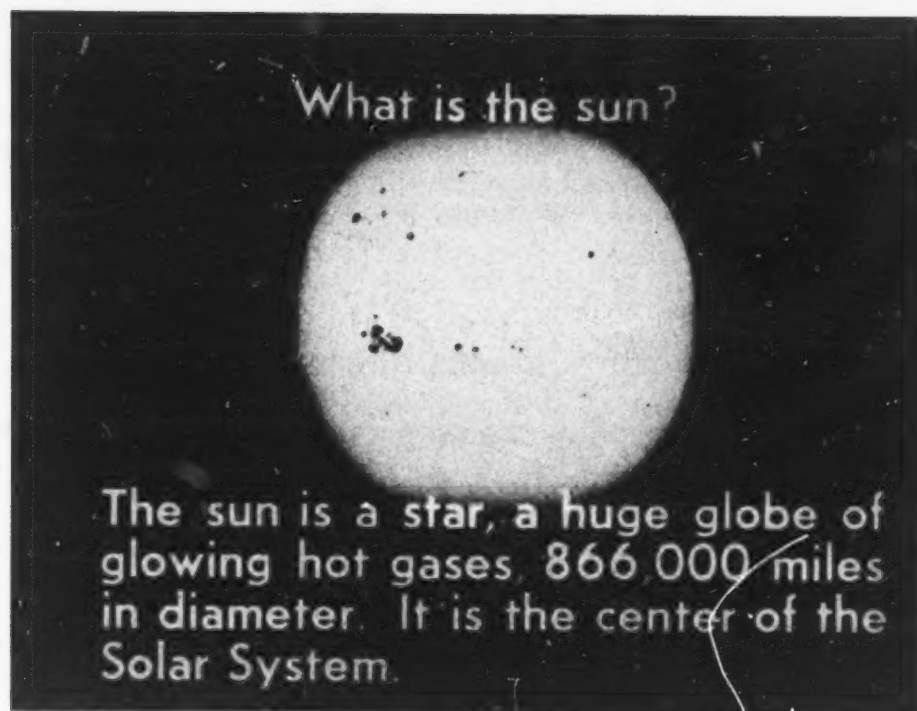
The revision aimed to convey the impression of great heat by making the sun appear brighter and by making the margins of the sun less clean cut. Also, focus was given to the relevant information by reducing the number of irrelevant statements from two to one.

Table 3 shows that almost all students were aware, after seeing either version, of the characteristics of the sun.

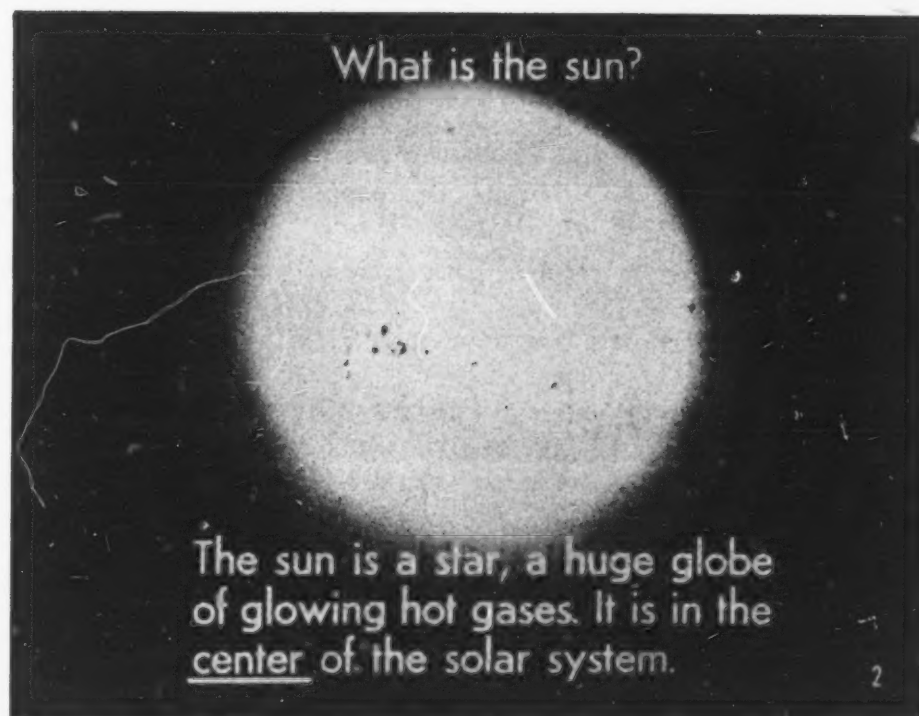
TABLE 3

Percent Choosing Various Responses to Item 3

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
H	72	68	72	71	59	61
1	3	1	0	0	2	2
2	3	0	0	0	0	0
3	1	0	1	1	0	0
4	93	99	99	99	98	98



Frame 2, Original



Frame 2, Revision

The relative size of the earth and sun constitutes the significant content of frame 3. Test items 4 and 5 were supposed to measure the learning of the appropriate information.

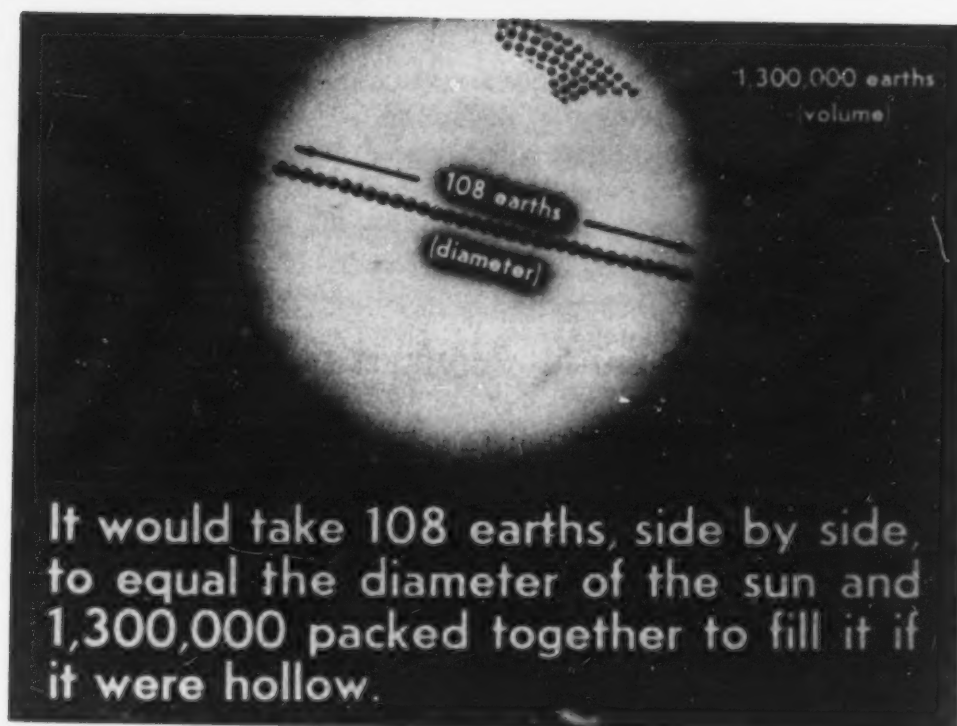
4. How many earths side by side would it take to equal the diameter of the sun?

1. 50
2. 108
3. 866,000
4. 1,300,000

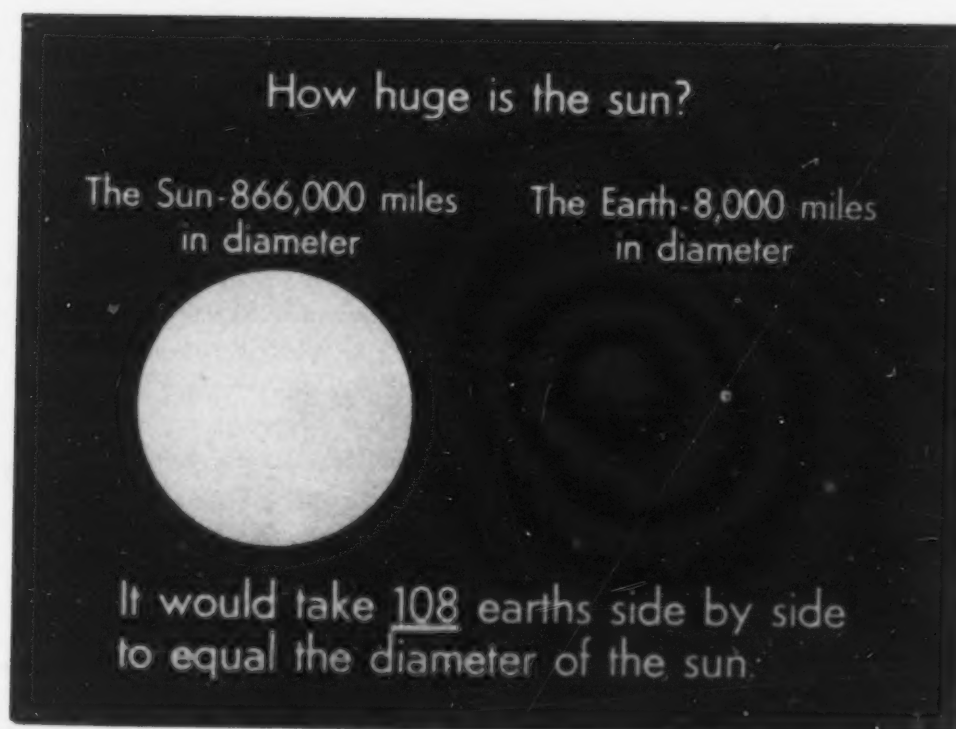
5. Which pairs show the relative size of the sun and earth?

1. Earth 	Sun 	2. Earth 	Sun 
3. Earth 	Sun 	4. Earth 	Sun 

As can be seen from Table 4 and 5, significantly higher proportions of all groups seeing the revised filmstrip passed item 4, but there were no significant differences in proportions passing item 5. Item 4 calls for the student to select the correct ratio of the earths diameter relative to that of the sun. The correct response could be made to item 4 by reference solely to the verbal element of the filmstrip. The differences in this verbal element are (1) the heading of the revised frame alerts the learner to the huge size of the sun, (2) the actual diameters of the earth and sun



Frame 3, Original



Frame 3, Revision

are shown in the revision, and (3) the revision omits reference to the relative volumes of the earth and sun.

Significant differences in favor of the revised filmstrip were found at all grade levels tested in terms of the proportions selecting the correct response. Significant differences in proportions selecting the distractor that included a ratio related to the relative volumes of the earth and sun were also found for grades 5, 6 and 7, although these differences "washed out" at the tenth grade level.

TABLE 4
Percent Choosing Various Responses to Item 4

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	3	1	0	4	0	0
2	39	71**	58	89**	72	88*
3	26	24	21	6	14	10
4	32	4	21	1	14	2

*Significant at .05 level.

**Significant at .01 level.

Interestingly enough, item 5, which required students to select the right pair of non-verbal representations of earth and sun, revealed no significant differences at any level. The fact is that more than 5 out of 6 students were able to select the response that was most nearly accurate regardless of which film-strip version they saw.

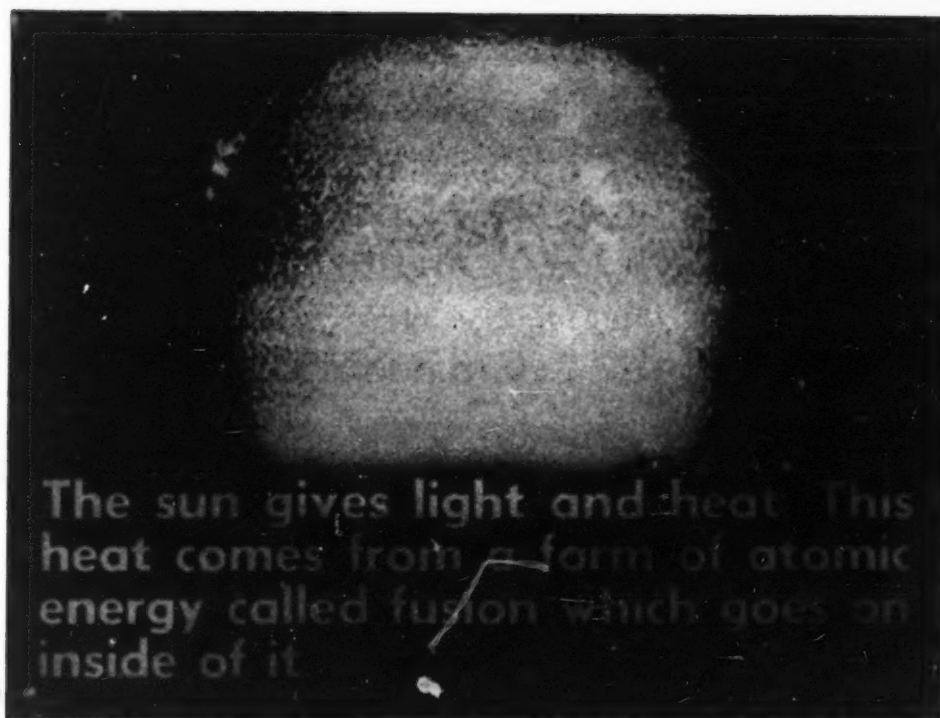
TABLE 5
Percent Choosing Various Responses to Item 5

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	3	4	6	1	3	5
2	84	89	93	92	95	91
3	10	7	1	6	0	2
4	3	0	0	1	2	2

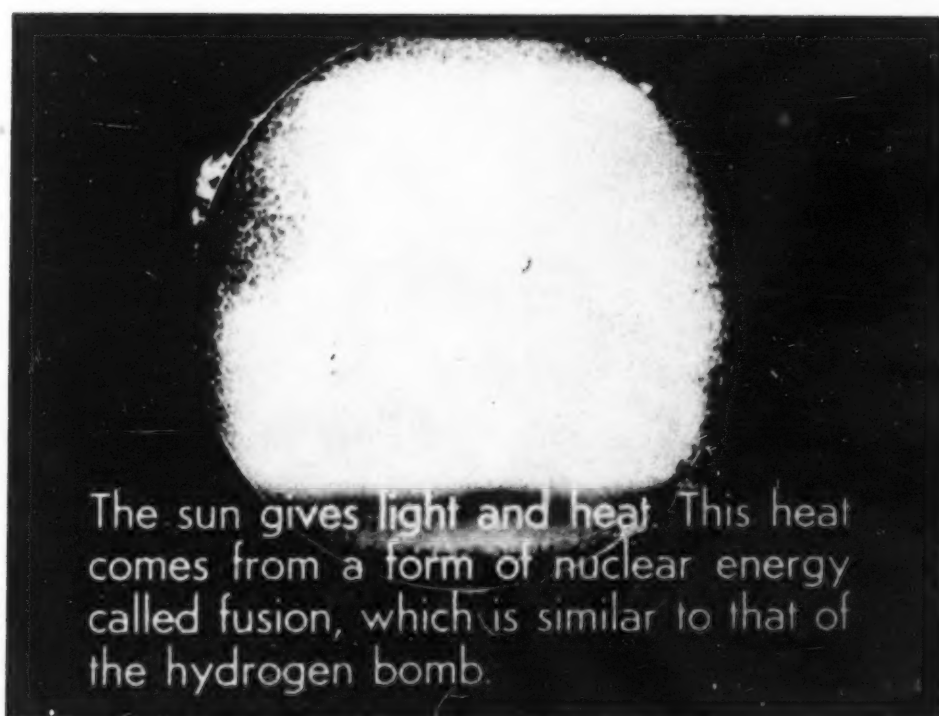
Item 6, shown below, was based on information presented in caption of Frame 4, which was changed in the revision in the interest of accuracy to refer to the source of the sun's heat as nuclear rather than atomic energy. In addition, the analogy of the hydrogen bomb was included in the revised caption.

6. The sun gives light and heat. This heat comes from

1. the reflected heat from the stars
2. nuclear or atomic energy
3. fires burning on the surface
4. molten lava on the surface



Frame 4, Original



Frame 4, Revision

As can be seen from Table 6, the only significant differences

TABLE 6
Percent Choosing Various Responses to Item 6

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	25	24	24	9	9	13
2	50	57	59	82*	77	69
3	18	15	17	9	9	16
4	7	4	0	0	5	2

*Significant at the .01 level.

in proportions passing item 6 were found in grade 7. If this can be explained by considerations other than chance, the explanation probably is the reference to the bomb, because the words "atomic" and "hydrogen" were both used in the test item.

Frame 5 states the period of rotation of the sun and shows one way in which this fact can be demonstrated. Test items 7 and 8 are included in order to test the possession of these two bits of information, in the order given.

7. The sun turns on its axis once

1. each day
2. every $10\frac{1}{2}$ days
3. every $24\frac{1}{2}$ days
4. each year

As can be seen by Table 7, the majority of students at all grade levels knew the period of the sun's rotation after seeing either version of the filmstrip. The most common errors were such as to suggest that the sun's period of rotation was confused with that of the earth's rotation or revolution. Very few students apparently derived the wrong impression from the difference in dates shown for consecutive observations of sun spots, which, coupled with an error that might be expected; namely, forgetting that the elapsed time should be about doubled to get the total rotation time, would have resulted in a selection of the second distractor.

TABLE 7
Percent Choosing Various Responses to Item 7

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	7	9	17	13	10	8
2	3	0	0	7	3	5
3	61	67	71	61	78	80
4	29	24	12	19	9	7

Table 8 reveals significant differences in favor of the revised filmstrip on item 8, which tests knowledge of how the period of the sun's rotation is demonstrated. These differences are

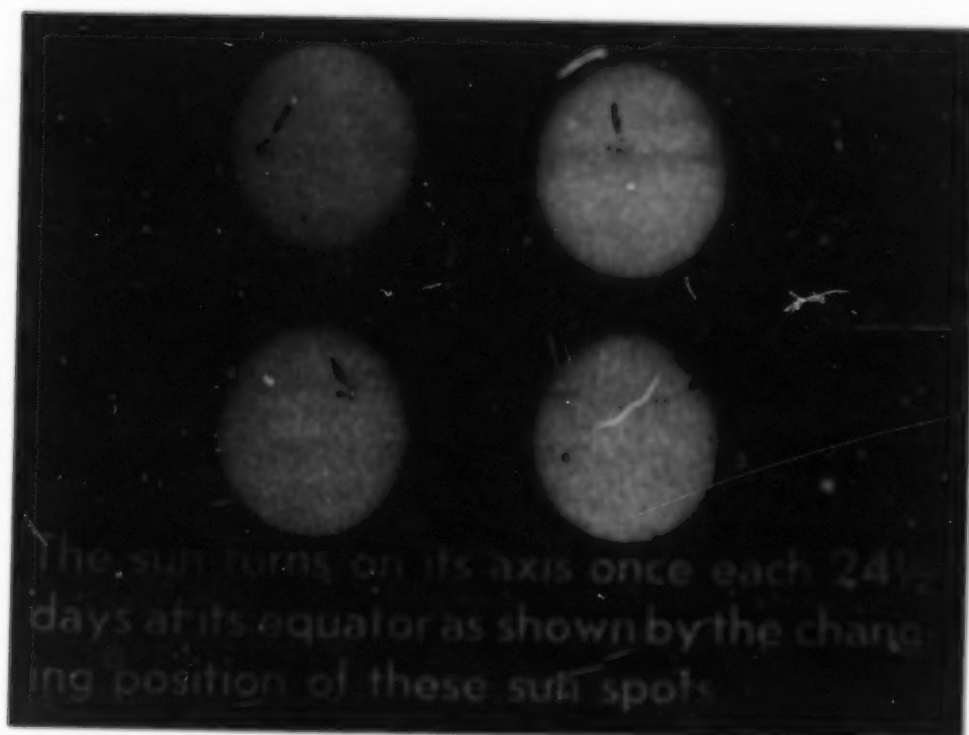
8. We can tell that the sun turns on its axis because of
1. the changing position of sun spots
 2. the difference in cloud formations
 3. its effect on the earth's orbit
 4. all of these

confined to grades 5, 6 and 7. They may be attributable to the addition of dates of observation in the revised filmstrip frame or to the emphasis given the relevant information in the revised filmstrip by setting it off in a separate sentence instead of incorporating it in a phrase within a complex sentence.

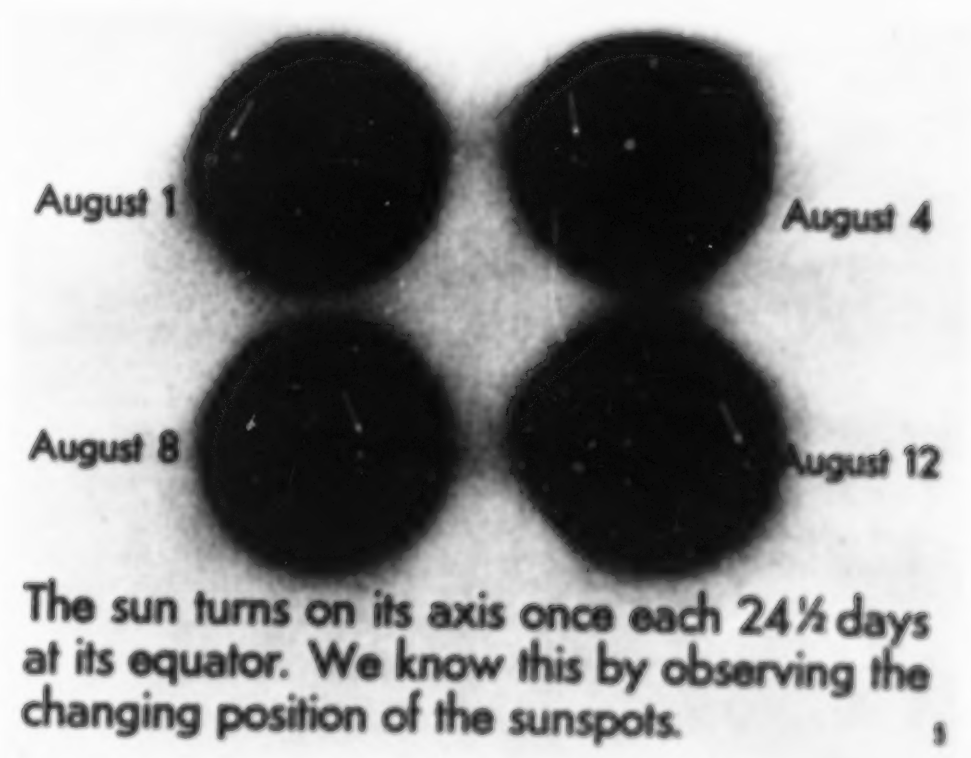
TABLE 8
Percent Choosing Various Responses to Item 8

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	45	73*	54	77*	72	62
2	10	4	3	1	3	3
3	27	10	17	11	15	15
4	18	13	26	11	10	20

* Significant at the .01 level.



Frame 5, Original



Frame 5, Revision

Another measure of the students' understanding of the sun's rotation was provided by test item number 9, shown below:

9. A scientist looks at the sun through a telescope and sees spots on the left side of the disk. Where will these spots be 12 days later?

1. in the same place
2. on the right side
3. in the center
4. toward the top

It will be recalled that the information required to respond correctly to the item could be inferred from the original filmstrip, but the revision provided an added clue by giving dates of successive observations of sunspots.

Table 9 shows that significantly more students who had seen the revised filmstrip responded correctly. The differences appeared at all grade levels tested.

TABLE 9
Percent Choosing Various Responses to Item 9

Choice	Grade 5-6		Grade 7		Grade 10	
	F50	F5R	F50	F5R	F50	F5R
N	72	68	72	71	59	61
1	4	0	12	3	14	7
2	43	60*	57	73*	43	63**
3	30	18	15	17	17	23
4	23	22	15	7	26	7

*Significant at the .05 level.

**Significant at the .01 level.

Frame 6 provides information on the speed and direction of the sun's motion through space. In the original, the pictorial element included a caption and an arrow at the left of the symbol for the sun. The caption stated the speed of the sun through space. In the revision, the caption was placed to the right of the symbol for the sun, and the sun symbol was moved correspondingly to the left. This modification was made on the assumption that the most attractive part of the frame was the head of the arrow leading the direction of motion, and that to locate the speed information near it would tend to make that information more readily learned.

The caption at the bottom of the frame in the original included the information that the direction of the sun's motion is toward the constellation Hercules. Since this information is not in the common knowledge, it was thought that it might be distracting rather than reinforcing for the viewer. Accordingly, this was omitted in the revision, and, in order to make the captions of approximate equal length, the words, "question: how fast does the sun move?" were added.

Test item 10, repeated below, calls for the student to identify the appropriate speed of the sun in miles per second.

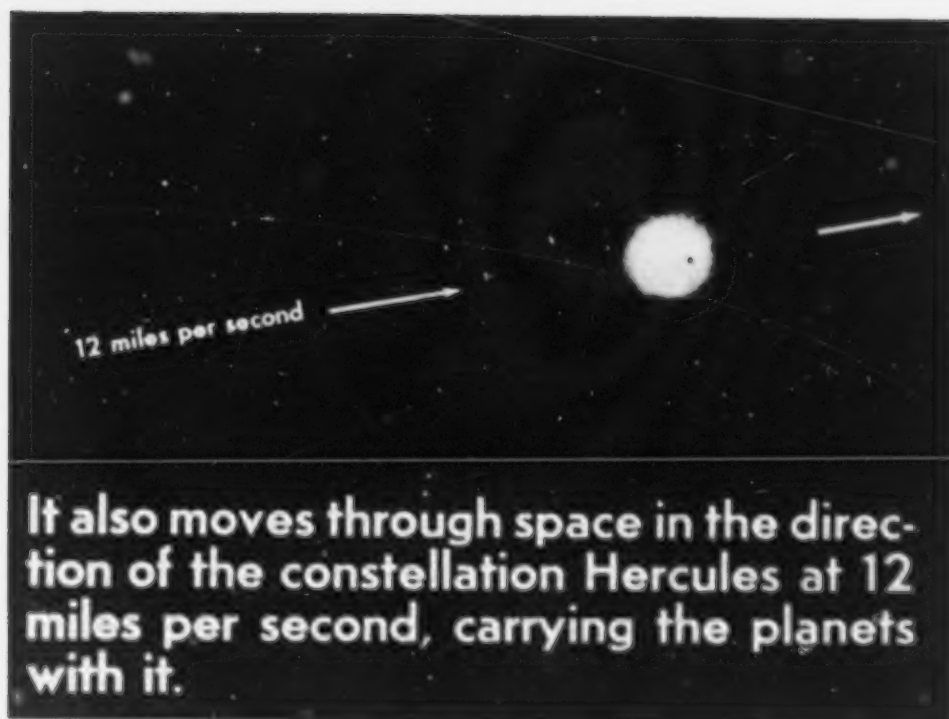
10. The whole solar system moves through space at a speed of
 1. 12 miles per second
 2. 32 miles per second
 3. 52 miles per second
 4. 62 miles per second

As can be seen from Table 10, the majority of students responded correctly to the tenth test item. In every case, the greater proportion of students who had seen the revision responded correctly, and this difference was significant at the five percent level in the seventh grade groups.

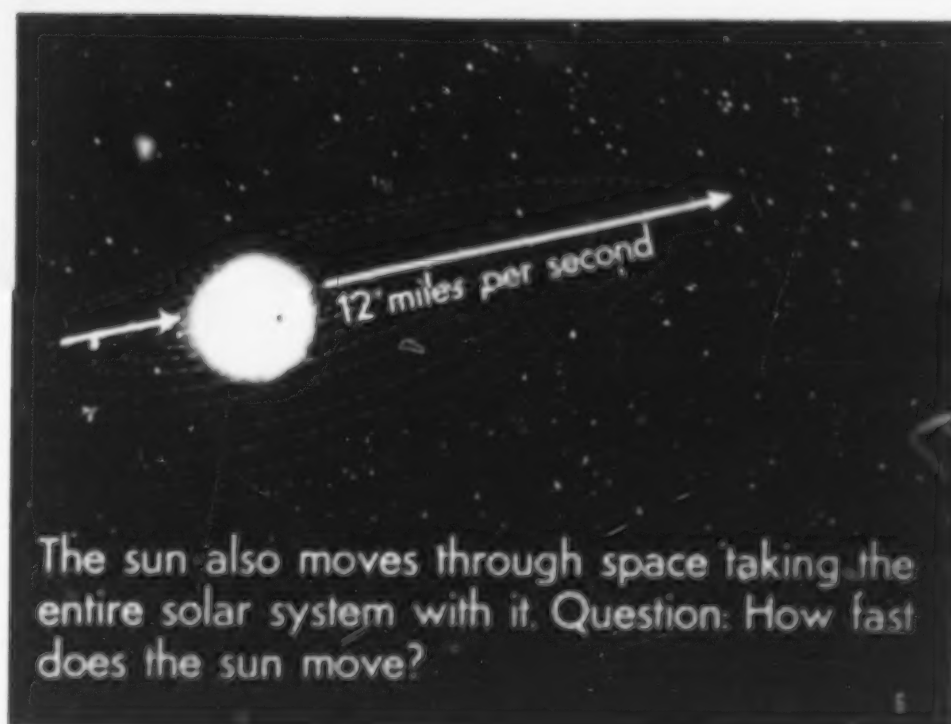
TABLE 10
Percent Choosing Various Responses to Item 10

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	71	74	78	96*	81	85
2	11	13	7	3	9	3
3	7	6	4	1	5	7
4	11	7	11	0	5	5

*Significant at the .05 level.



Frame 6, Original



Frame 6, Revision

Frame 7 is a drawing of planets circling the sun. In the revision, the sun was made to appear brighter, and the planets were enlarged in size, so that it would be possible to show more clearly that the sides facing the sun were light, and the sides away from the sun were dark.

The captions were identical on FSO and FSR.

Test item 11 repeated below, concerns the student's ability to associate the word "orbit" with the path of a planet around the sun. It did not measure information that was relevant to the modifications, and no significant differences were found between the groups who saw the two versions of the filmstrips.

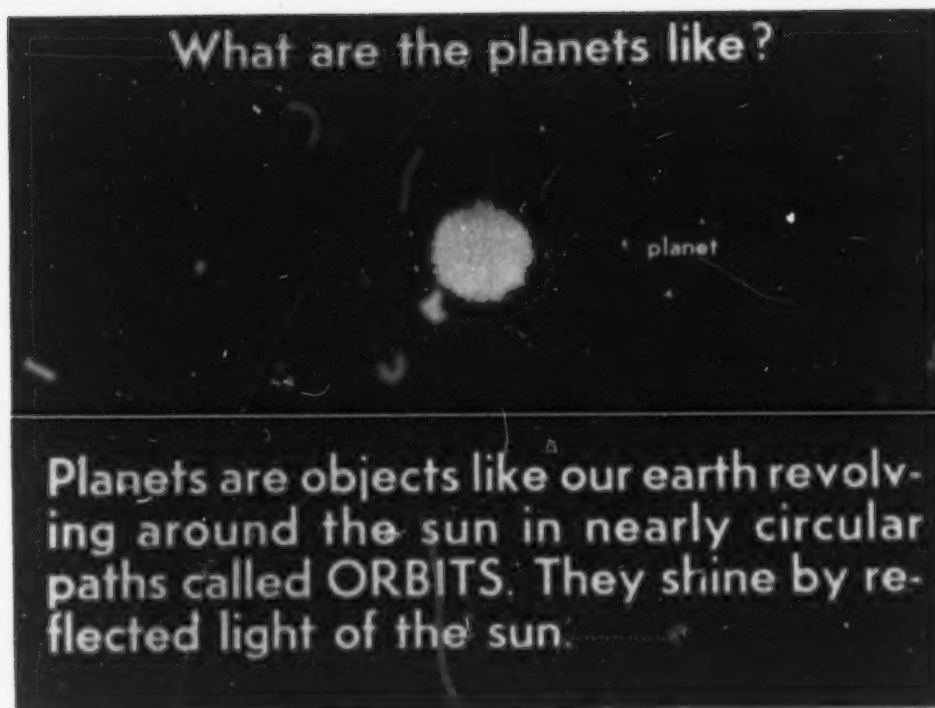
11. The planets revolve around the sun in nearly circular paths called

1. positions
2. rotations
3. revolutions
4. orbits

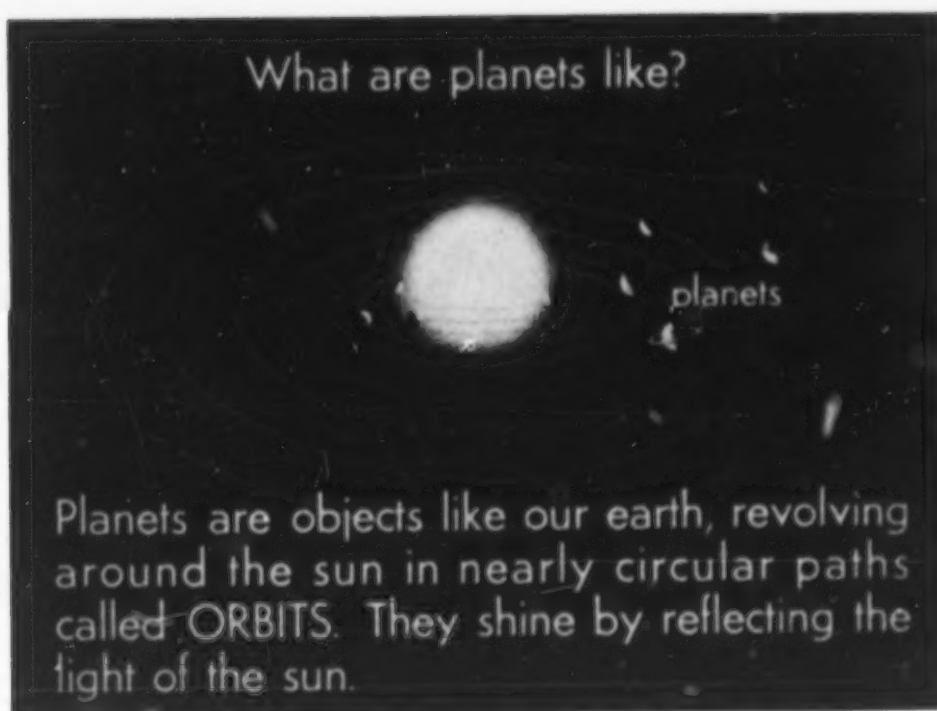
TABLE 11

Percent Choosing Various Responses to Item 11

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	1	0	1	0	81	85
2	21	18	8	15	9	3
3	24	26	29	17	5	7
4	54	56	62	68	5	5



Frame 7, Original



Frame 7, Revision

Test item 12 relates to the origin of the light that observers on the earth see coming from the planets.

12. At night we can see some of the planets shining in the sky.

1. the glare of the polar caps
2. light reflected from the planets' moons
3. fire on the surface of the planet
4. the reflected light of the sun

Table 12 shows that there were no significant differences in responses to item 12 among the various groups.

TABLE 12

Percent Choosing Various Responses to Item 12

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	11	12	6	6	3	7
2	18	16	11	17	8	10
3	1	1	4	0	0	5
4	70	71	79	77	89	78

It will be noticed, however, that seventy per cent or more of the students responded correctly to item 12 regardless of the filmstrip version that they saw.

Frame 8 lists the nine known planets and compares them in size with the sun. Test item 13 is based on this frame.

13. In comparing the sun to the planets in our solar system in size, which of the following is correct?

1. some planets are larger than the sun



2. Jupiter, by itself, is as large as the sun



3. All the planets together are as large as the sun



4. All the planets would fit in a small corner of the sun

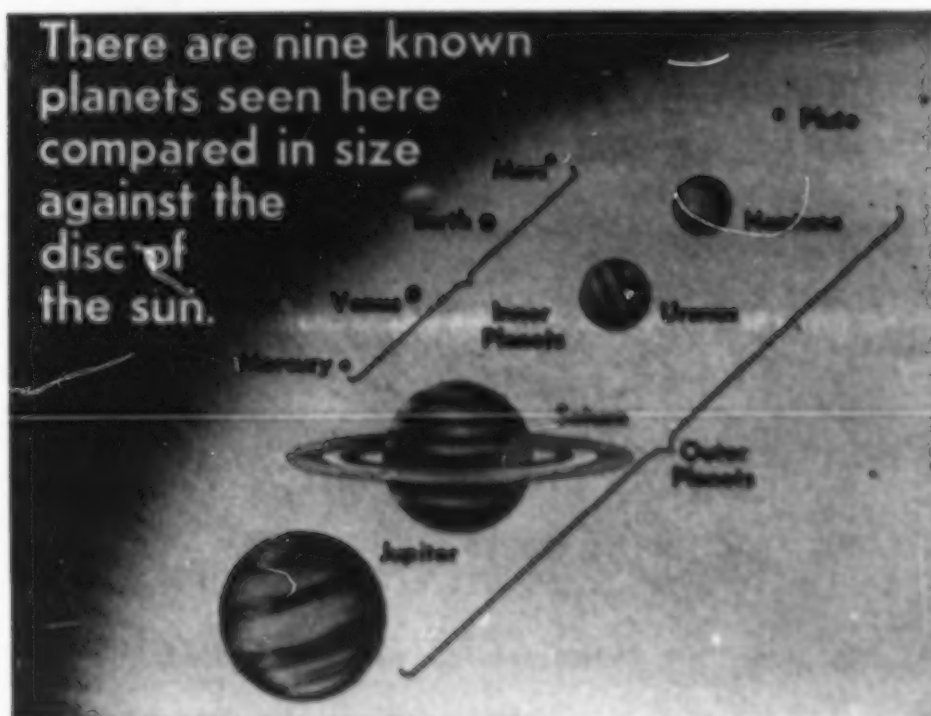


Modifications in the revised filmstrip involved making the edge of the sun's disc sharply defined rather than "feathered off", and in putting the labels on the planets in positions in which the labels were more clearly associated with the planets that they were intended to identify. The caption was also changed by inserting the words "a portion of" in the interests of somewhat greater accuracy.

Table 13 shows that, although in the elementary grades and the tenth grade, differences almost approached a significant level in favor of the FSR, there were no statistically significant differences in responses to your Item 13.

TABLE 13
Percent Choosing Various Responses to Item 13

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	15	10	6	9	3	7
2	11	10	11	17	9	3
3	22	13	14	10	17	7
4	52	67	69	64	71	84



Frame 8, Original

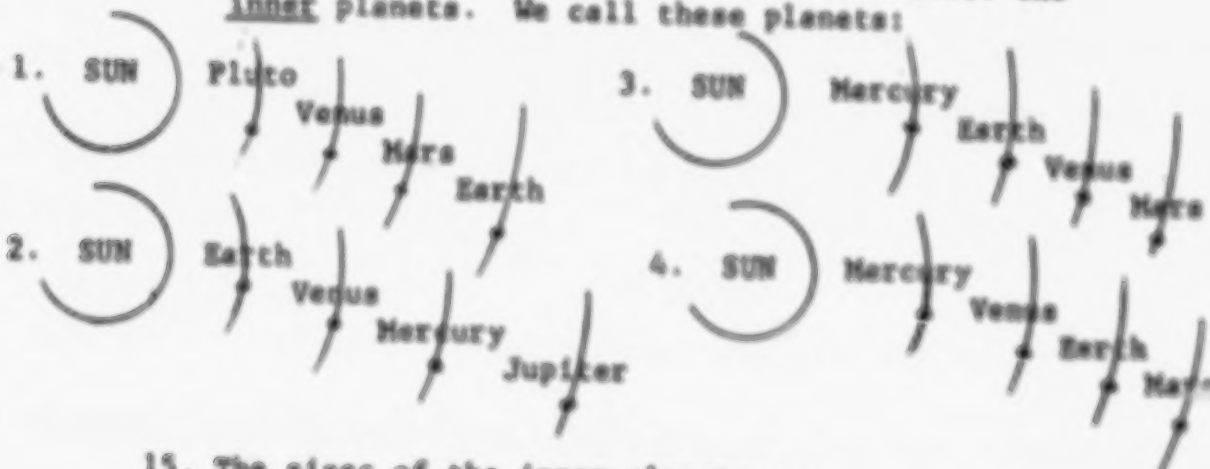


Frame 8, Revision

A number of modifications were made on Frame 9 which deals with the inner planets. The representation of the sun was moved from the lower right to the upper left so that the progression of the planets would be from left to right -- the normal reading sequence -- in order of their distance from the sun. The labels on the planets indicating their distance from the sun were changed so that 36,000,000 was changed to 36 million. The representations of the planets also were enlarged somewhat in order to make them more easily observable. Finally, in the caption the key words "is small" were underlined, and a sentence was added indicating the location of the earth as the third planet from the sun.

The following three test items related to information presented in Frame 9:

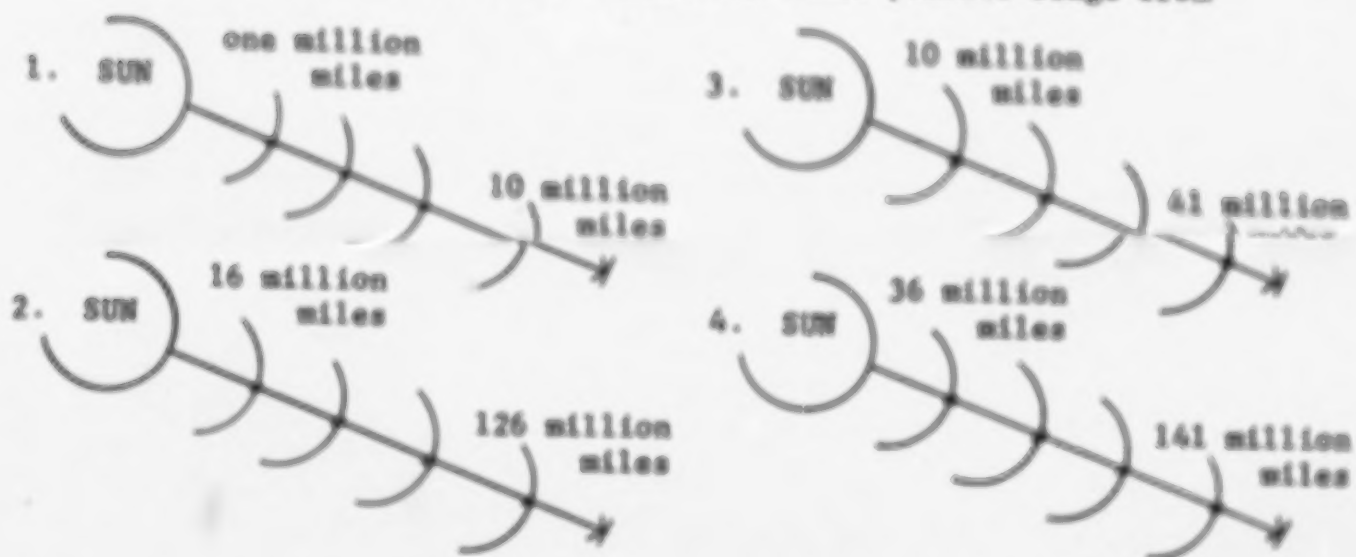
14. The four planets nearest the sun are called the inner planets. We call these planets:



15. The sizes of the inner planets are

1. about the same as the outer planets
2. all quite large
3. all quite small
4. unknown

16. In distance from the sun, the inner planets range from



It will be noted that test Item 16 employs the style that is employed in the labels on the revised filmstrip Frame 9; that is, "10 million miles" instead of "10,000,000 miles". Table 16, however, shows that there were no statistically significant differences between the filmstrips although the students seeing the revision consistently did better than those who saw the original.

TABLE 14
Percent Choosing Various Responses to Item 14

Choice	Grade 3-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
H	72	68	72	71	59	61
1	33	10	6	6	2	3
2	10	10	6	4	7	2
3	22	9	25	8*	19	20
4	35	71**	63	82*	72	75

*Significant at the .05 level.
**Significant at the .01 level.



Frame 9, Original



Frame 9, Revision

TABLE 15

Percent Choosing Various Responses to Item 15

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	6	15	7	3	3	5
2	24	7	10	17	12	13
3	57	65	75	63	82	79
4	13	13	8	17	3	3

TABLE 16

Percent Choosing Various Responses to Item 16

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	13	16	15	12	21	8
2	27	12	20	16	26	15
3	14	18	6	4	7	20
4	46	54	59	68	46	57

Test item 14 required the students to identify the inner planets and to recognize their proper sequence and distance from the sun. In grades 5, 6, and 7 there were significant differences in proportion passing this item in the groups that saw the revised filmstrip. Choices 3 and 4 included all the inner planets but had them in two different sequences. These two choices drew 80 to 95 percent of the responses of all groups except the fifth and sixth grades who saw the original film. More than two out of five of these students did not notice the error of including an outer planet or two, or the error of improper order of planets from the sun outward.

Item 15 tested the knowledge of the general size of the inner planets, and Item 16 tested the knowledge of the distance of the inner planets from the sun. There were no significant differences among groups with respect to the proportion selecting various responses to Item 15 or 16. Statistically insignificant but consistent differences favored the revision of Item 16.

Frame 10 corresponds to Frame 9, but refers to the outer planets. The same modifications were made except that, for some reason, the words "from the sun" had been omitted from the original version. This phrase was restored in the revision. Test items 17, 18 and 19 were intended to relate to the content of Frame 10.

17. The five planets farthest from the sun are called the outer planets. By name we call these planets:

1. Saturn, Uranus, Neptune, Pluto, Mars
2. Earth, Jupiter, Uranus, Neptune, Pluto
3. Jupiter, Saturn, Uranus, Neptune, Pluto
4. Neptune, Uranus, Saturn, Jupiter, Earth

18. In distance from the sun, the outer planets range from:

1. 80 to 210 million miles
2. 450 to 900 million miles
3. 480 to 3,665 million miles
4. 540 to 7,671 million miles

19. In all but one of the following pairs the larger planet is listed first. Choose this pair.

1. Neptune, Pluto
2. Earth, Venus
3. Jupiter, Saturn
4. Mars, Mercury

Each of the responses except the correct response to Item 17 has included in the list of five one of the inner planets. Table 17 indicates that about 3 out of 4 students were able to identify the so-called outer planets. The differences between the original and revised filmstrips were not significant, but consistently in favor of the revision.

TABLE 17

Percent Choosing Various Responses to Item 17

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	15	18	11	14	8	2
2	10	4	8	4	2	5
3	63	74	73	74	85	88
4	12	4	8	8	5	5



Frame 10, Original



Frame 10, Revision

Test item 18 required the students to identify the proper range of distances from the sun from the nearest outer planet to the most distant. The format of the past item was somewhat different from that of the corresponding item relating to inner planets. In the former case the test item included a diagram, whereas in the present case only the numbers were used in the test item. There were no significant differences among the groups, and the frequency of correct response was disappointingly low. Even among the tenth graders, the responses were almost what one might expect by chance.

Responses to test item 19 cannot be interpreted because, through an editorial error, all of the responses were, in effect, correct. It is interesting to note, however, that by far the most frequent response at all grade levels would suggest that students believed that Saturn is larger than Jupiter.

TABLE 18

Percent Choosing Various Responses to Item 18

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	21	12	7	9	19	18
2	4	18	21	21	14	20
3	33	43	43	38	40	29
4	42	27	29	32	27	33

TABLE 19

Percent Choosing Various Responses to Item 19

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	14	12	10	8	17	8
2	20	18	15	14	14	15
3	48	43	60	59	55	57
4	18	27	15	19	14	20

Frame 11 presented information concerning the size of the planets. Rather drastic modifications were made in the revision. The original frame presented more or less stylized drawings of the planets arranged in three rows in the order of their distance from the sun. The moons of the planets were shown, although they were neither identified nor was any information concerning them presented. The caption indicated that the planets were drawn to scale, but measurement indicated that this was not strictly true.

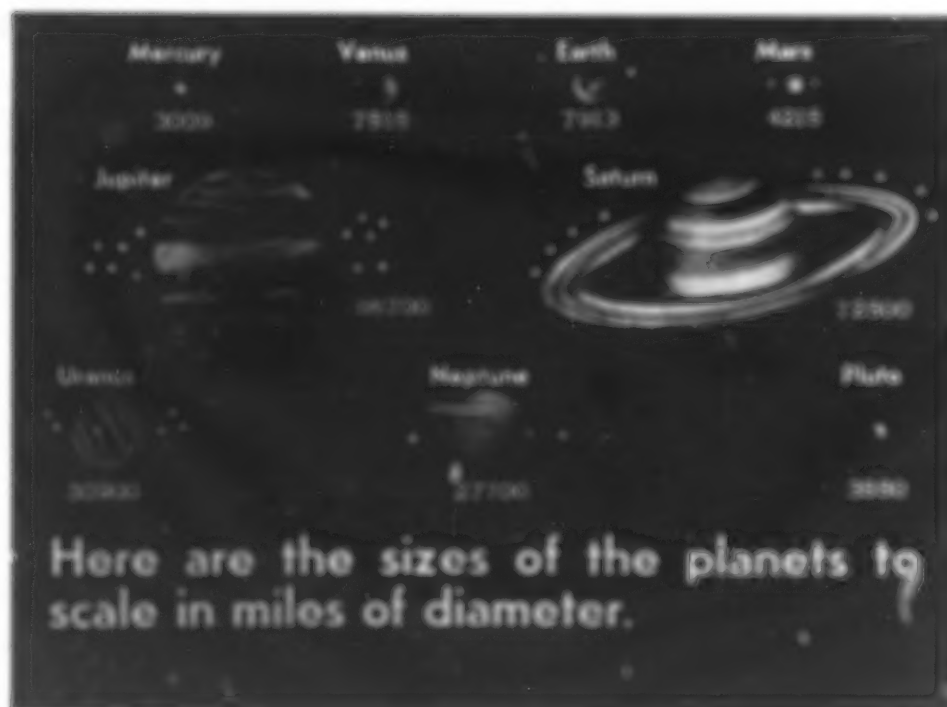
In the revision the margin of the frame was divided in scale units, and the planets were arranged in order of size instead of distance from the sun. The idea of iconicity was abandoned and planets were represented simply by circles of appropriate scale in diameter.

Test item 19, which has already been discussed, and Test item 20, which appears below, tested a sample of the information provided in the frame. Perhaps more information should have been sampled, or perhaps the modifications were actually ineffective. In any case, the responses to Item 20 indicate no significant differences between the versions.

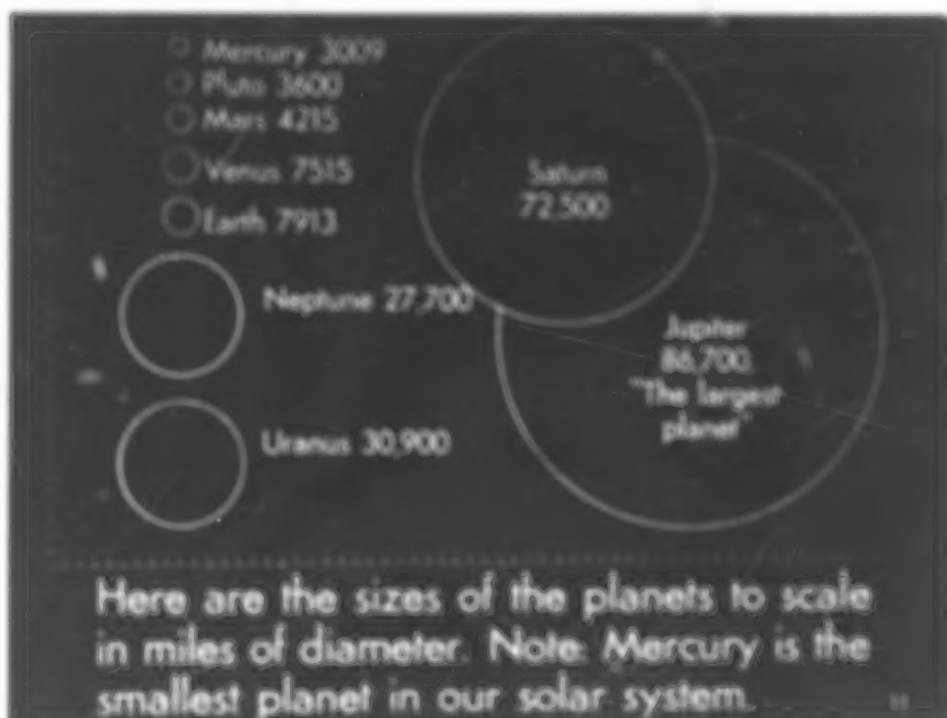
20. The largest planets in our solar system are:

1. Neptune, Jupiter
2. Saturn, Pluto
3. Uranus, Neptune
4. Jupiter, Saturn

Table 20 shows that the vast majority of the students were able to answer Item 20 correctly. The most common error was to include a Neptune among the largest two planets in the solar system.



Frame 11, Original



Frame 11, Revision

TABLE 20
Percent Choosing Various Responses to Item 20

Choice	Grade 3-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	24	15	17	18	14	16
2	7	6	6	3	2	7
3	10	12	8	7	2	3
4	59	67	69	72	82	72

Frame 12 has to do with the revolution of planets around the sun. It was modified in the revision by relocating the directional arrows on the orbits, by making the paths of the orbit of the two inner planets clearly pass on the viewer's side of the sun, and by making the representation of the planets themselves a little more visible.

Test item 21 required the students to identify the diagram which appropriately shows the direction of revolution of the planets around the sun.

21. Which diagram shows the correct movement of planets around the sun?



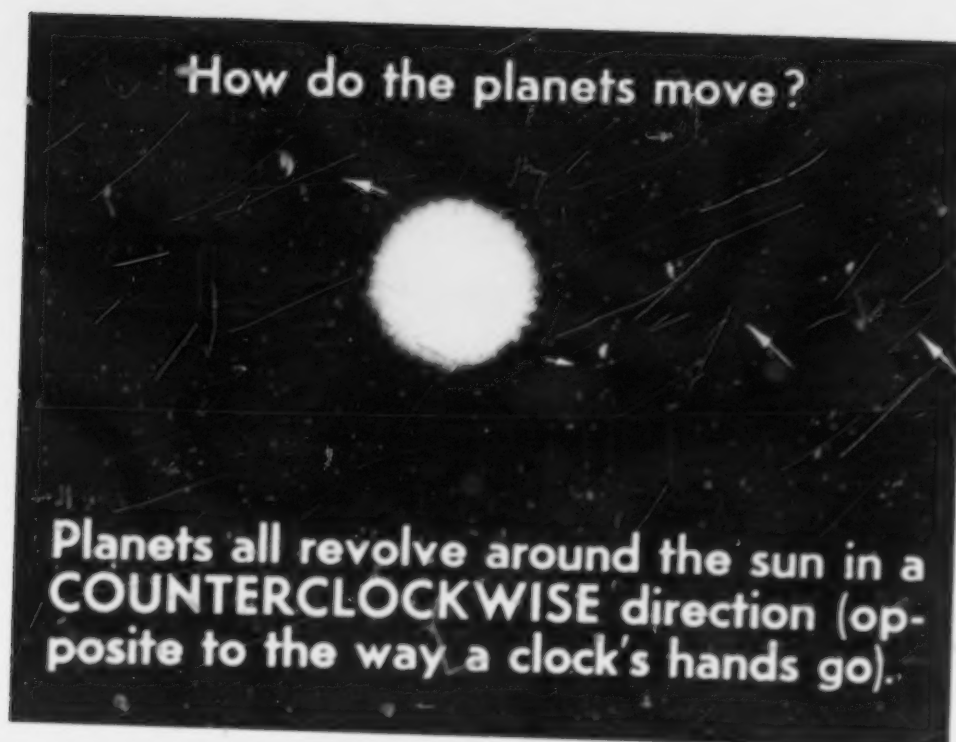
Table 21 shows that there were no significant differences in proportions passing item 21.

TABLE 21

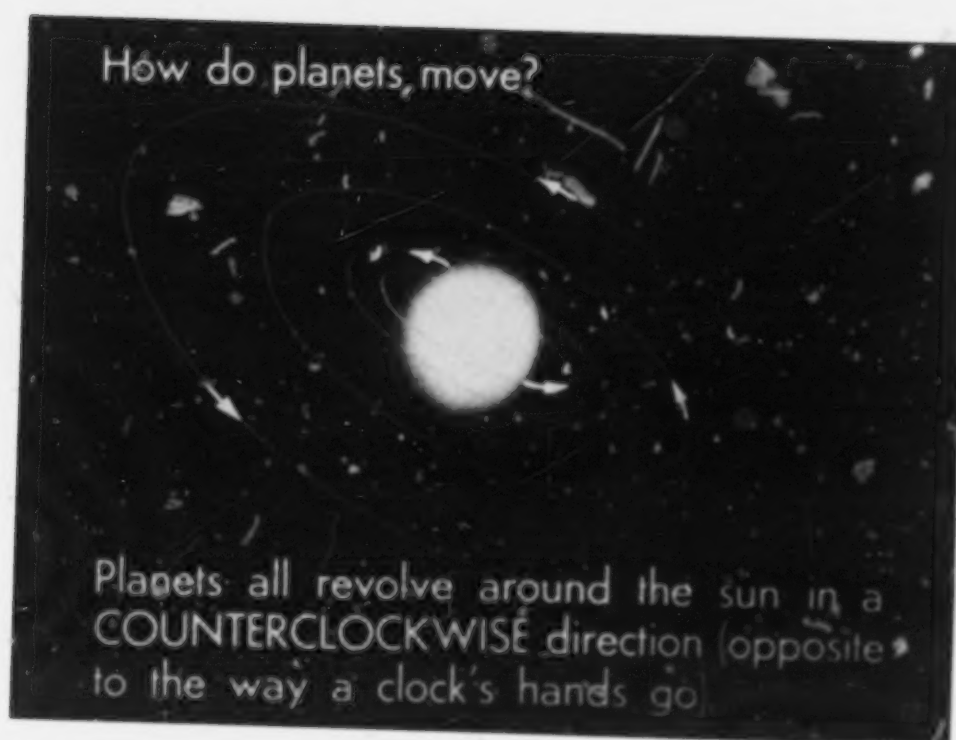
Percent Choosing Various Responses to Item 21

Choice	Grade 5-6		Grade 7		Grade 10	
	FSD	FERR	FSD	FERR	FSD	FERR
H	72	68	72	71	59	61
1	8	21	4	10	3	7
2	17	7	10	9	12	3
3	65	63	82	75	80	82
4	10	9	4	6	5	8

Two out of three fifth and sixth graders and four out of five seventh and tenth graders answered the item correctly. The most frequent error was to select the distractor that showed the planets going around the sun in a clockwise rather than a counterclockwise direction. This error was made consistently, but not statistically significant, less frequently by students seeing the revised filmstrip.



Frame 12, Original



Frame 12, Revision

The concept of year as related to the period of revolution of a planet is the substance of Frame 13. The frame was revised by putting the two planets shown (Earth and Mars) on opposite sides of the sun rather than on the same side, by labeling the Earth and Mars with capital letters instead of lower case, and by changing the label to 365 days = one year instead of having simply the label one "year".

A change in the caption was also instituted in making the revised filmstrip. It seemed that the important concept was the concept of year, so the caption was begun with reference to the year.

Items 22 and 23 relate to information presented in this frame.

22. What is a year in terms of each planet in the solar system?

1. The time it takes to make one-half of a revolution
2. The time it takes to go around the sun
3. The time it takes to turn on its axis
4. The speed of rotation

23. Which planets have the same length year?

1. Earth and Mars
2. Mars and Pluto
3. Mercury and Pluto
4. None have the same

Table 22 shows that the majority of students were able to respond correctly to an item testing their understanding of the concept of "year" regardless of which version of the filmstrip they saw.

TABLE 22
Percent Choosing Various Responses to Item 22

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	4	6	1	0	3	2
2	59	52	77	73	87	86
3	21	24	15	19	5	7
4	15	18	7	8	5	5

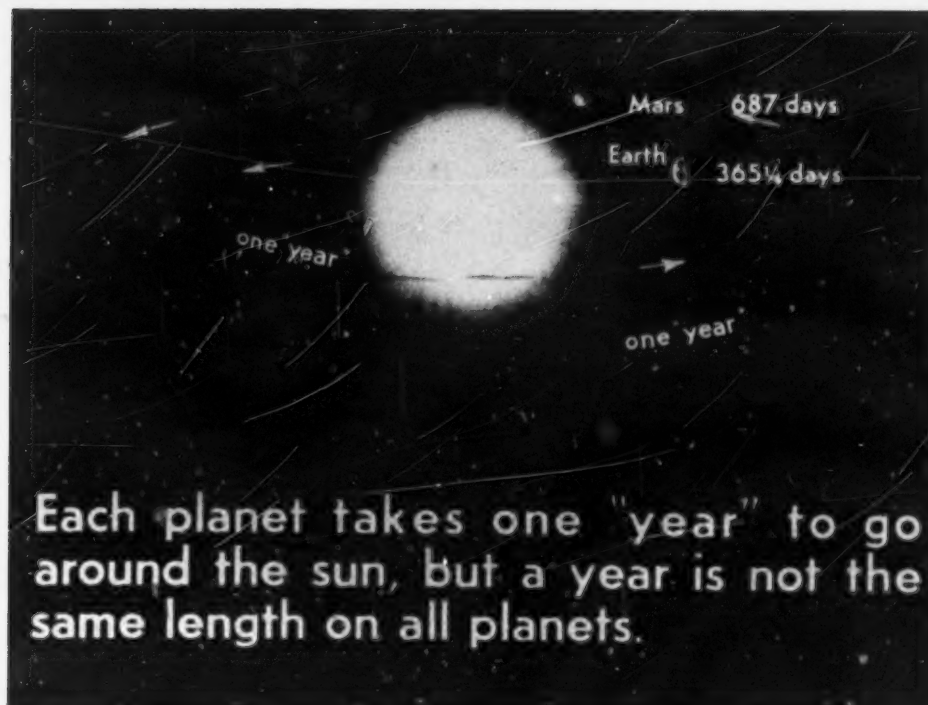
Generally the most frequent error was to identify the year as the period of time it takes a planet to turn on its axis. This confusion between rotation and revolution is likely a carry over from the previous knowledge of the students. Certainly the frame does not emphasize the distinction, although it deals only with the concept of revolution and excludes consideration of rotation altogether.

Test item 23 required students to recognize the fact that no two planets in the solar system have the same length of year measured in earth days.

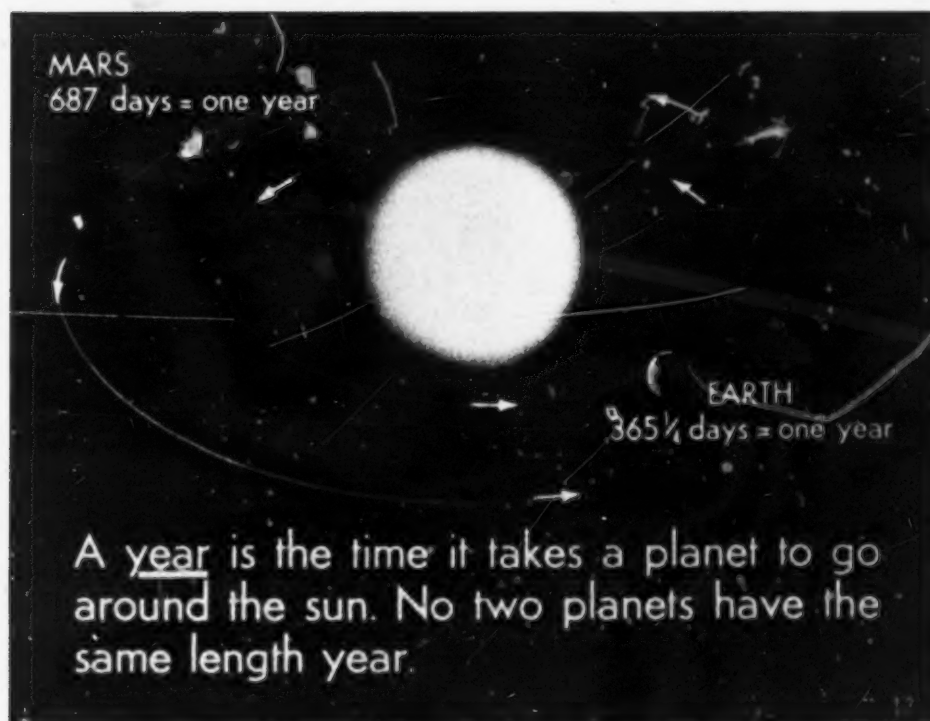
TABLE 23
Percent Choosing Various Responses to Item 23

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	15	12	10	3	7	5
2	6	6	1	4	0	0
3	11	1	1	0	2	10
4	68	81	88	93	91	85

As can be seen from Table 23, Item 23, this fact was correctly responded to by more than two out of three students regardless of which version they saw. Except for the tenth graders, differences in proportion passing the item favored the revised filmstrip, but not at a significant level. The most frequent error was to assume that the two planets shown in the filmstrip frame -- Earth and Mars -- had the same length of year.



Frame 13, Original



Frame 13, Revision

The original filmstrip has two frames devoted to presenting information regarding the length of time it takes various planets to revolve around the sun, and the orbital speed of these planets. In general, the more distant planets not only take longer to complete one revolution around the sun because of the increased length of their orbital path, but also because they travel at a slower rate of speed.

The original filmstrip showed a diagram of the sun at the left of the frame, with the four inner planets stretching out in a straight line to the right of the sun. On the orbital lines were printed labels that show the period of revolution in earth days and the orbital speed in miles per second. A second frame has the sun in the lower left hand corner and the major planet stretched out in a diagonal toward the upper right hand corner. The same type of information is on these orbits.

In the revision, it was assumed that the information which shows the negative correlation between the period of revolution and orbital speed could best be shown in tabular form. Consequently, the revision showed a single table in place of the two frames covering the same material in the original.

Item 24 required the student to generalize from the information given in the filmstrip to an imaginary situation which could be solved by the proper application of the information.

24. Imagine that an astronomer discovered two new planets, one beyond Pluto and the other near Mercury. Which of the following statements would be most likely to be correct?

1. The planet beyond Pluto would have to take more than a hundred years to go around the sun.
2. The planet beyond Pluto would travel about 5 miles per second.
3. The planet near Mercury would go around the sun in about 10 months.
4. The planet near Mercury would travel about 5 miles per second.

As can be seen from Table 24, most students tested, regardless of which version of the filmstrip they had seen, were unable to produce the correct response. Only in the case of the tenth graders did as many as about half respond correctly to Item 24.

TABLE 24
Percent Choosing Various Responses to Item 24

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	30	30	33	22	58	46
2	23	19	24	21	9	20
3	36	33	25	44*	26	23
4	11	18	18	13	7	11

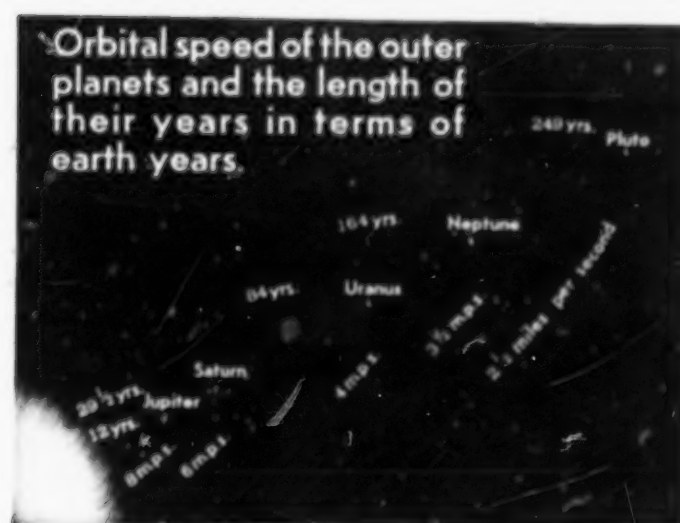
*Significant at the .05 level.

Responses of the fifth and sixth graders were almost randomly distributed among the four choices. This was also the case of the seventh graders who saw the original, although the students seeing the revised edition were more likely to choose the third response, which was, of course, an erroneous response.

In view of the difficulty of the item, it is not possible to determine the relative merits of the revision and the original. It is possible, of course, to note that, except for the tenth graders, neither item apparently produced learning on the part of the students at the level required to respond correctly to the test item.



Frame 14, Original



Frame 15, Original

		Orbital Speed (in earth months) or miles per second	Time
Inner Planets	Mercury	3	30
	Venus	7 1/4	22 1/2
	Earth	12	18 1/2
	Mars	21	15
Outer Planets	Jupiter	144	8
	Saturn	354	6
	Uranus	1008	4
	Neptune	1968	3 1/2
	Pluto	2988	2 1/2

As the Planets get further away from the Sun their speed decreases and the length of time to make one revolution of the sun increases.

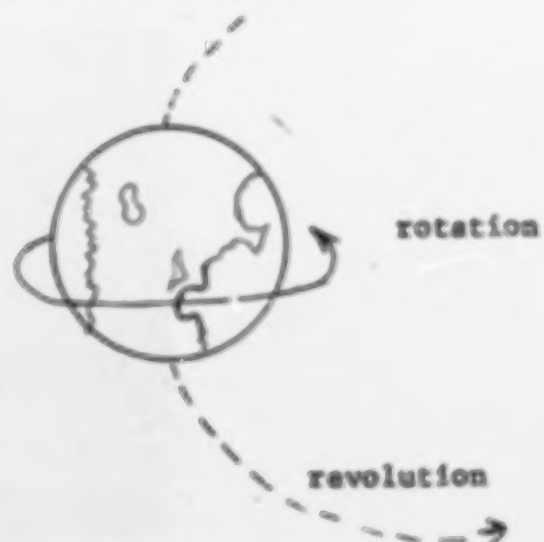
Frame 14-15, Revision

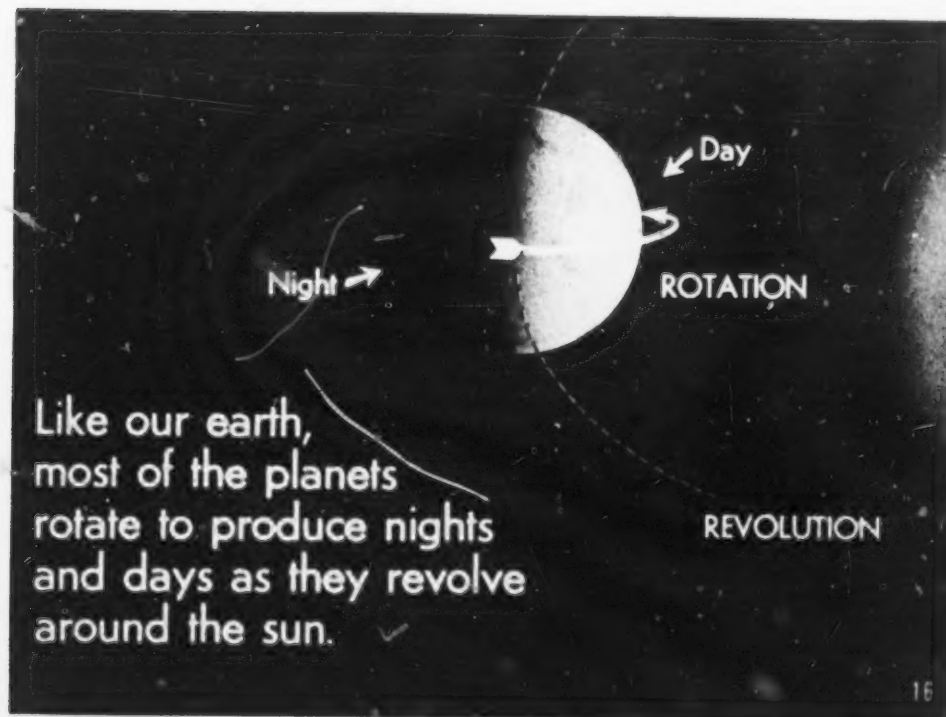
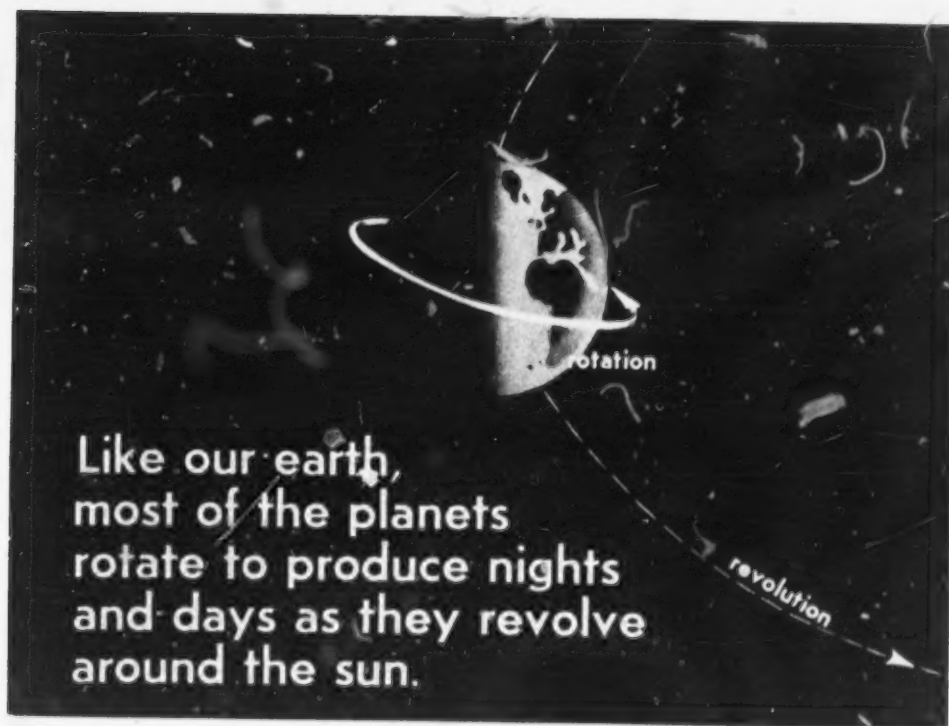
Frame 16 was intended to present information concerning the direction of the rotation and revolution of the earth and the incidental information of the position of the earth with respect to the sun. In revising the filmstrip, changes were made to the pictorial element only. The labels "rotation" and "revolution" were changed from lower case to capital letters and were enlarged. The sides of the earth in day and in night were indicated by labels, and the right hand margin was brightened to indicate the location of the sun at the right of the earth as seen in the frame. The "speed lines" used in original frame were removed. This last modification was intended to decrease the tendency for the students to assume that the motion represented on the frame was from the top of the frame down toward the bottom of the frame and to increase the likelihood that the motion would be interpreted as being outward in the direction of the students looking at the picture.

Test item 25, repeated below, referred to the information in Frame 25.

25. Refer to the diagram at the right. Which statement below is correct?

1. The words revolution and rotation should be interchanged
2. The arrow along side of revolution should point the other way
3. The side nearest the word rotation is in daylight
4. The side opposite the word rotation is in daylight





Frame 16, Revision

As can be seen from Table 25, the revision did not seem to result in any greater proportion of the students passing Item 25.

TABLE 25
Percent Choosing Various Responses to Item 25

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	24	11	15	12	12	8
2	13	24	18	19	10	17
3	36	39	40	51	66	55
4	27	26	27	18	12	20

Responses to item 25 were almost randomly distributed among fifth and sixth graders, although somewhat more answered correctly than answered incorrectly. Significantly more students answered the item correctly in the seventh and tenth grades, regardless of the version of the filmstrip that they saw. The selection of distractors did not show any consistent pattern.

Information about the direction and period of rotation of the planets is presented in Frame 17. In the original filmstrip, circles were used to represent the planets, and labels indicated the name of the planet and the period of its rotation. The sizes of the circles were roughly representative of the sizes of the planets, and, in the case of the larger planets, a line was drawn around the planet

presumably indicating the direction of rotation.

In the revision, the drawings of the planets were eliminated and there was substituted a table which showed the rotation period and direction of rotation of each planet where that information was known.

The original frame had a caption which implied that the direction of rotation of Pluto and Venus is known but that their periods of rotation are unknown. The caption in the revision avoided this interpretation by stating categorically that only Uranus is known to rotate clockwise, whereas the direction and period of rotation of Venus and Pluto were indicated as unknown.

Two test items were written to test the acquisition of information presented in Frame 17. The first of these, Item 26, required the students to identify the planet whose period of rotation is unknown.

26. Not all the rotation periods of the planets are known. Which two are unknown?

1. Mercury and Uranus
2. Venus and Pluto
3. Jupiter and Saturn
4. Neptune and Mars

Item 27 required the students to identify the planet having the shortest rotation period.

27. Which planet has the shortest rotation period?

1. Jupiter
2. Mercury
3. Uranus
4. Earth

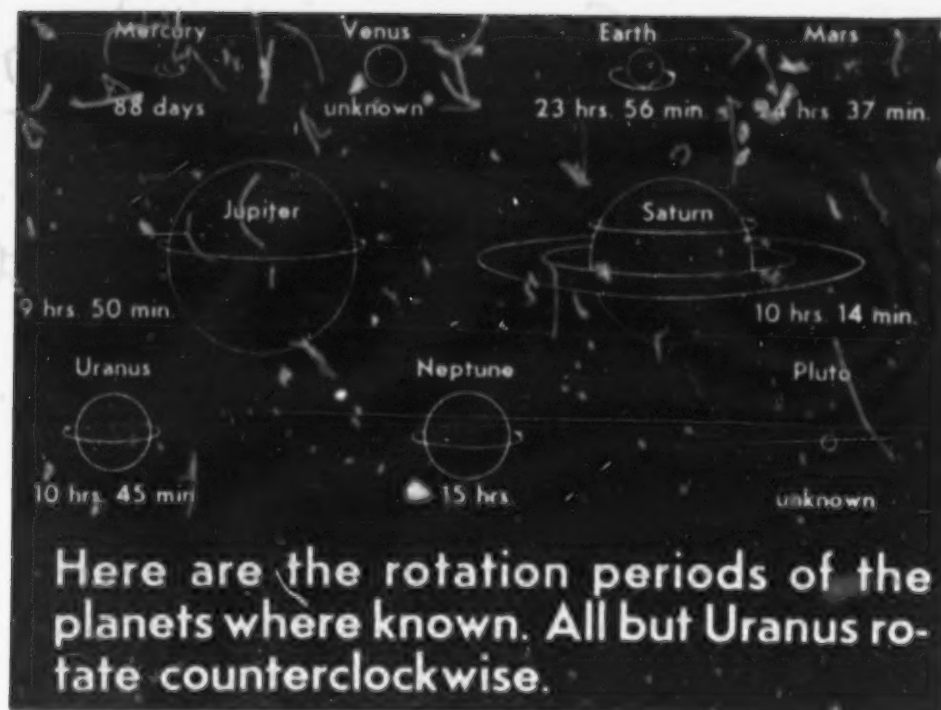
Table 26 presents information on the proportion of students selecting each of the alternatives for Item 26.

TABLE 26
Percent Choosing Various Responses to Item 26

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	24	12	15	11	14	7
2	48	64*	64	67	71	78
3	14	14	10	15	7	7
4	14	11	11	7	8	8

*Significant at the .05 level

Differences in proportions passing the items consistently favored the revised filmstrip, but these differences were significant only at the level of grades five and six. There were no consistent patterns of errors.



Frame 17, Original

PLANET	ROTATION PERIOD	DIRECTION OF ROTATION
Mercury	88 days	Counterclockwise
Earth	23 hrs. 56 min.	
Mars	24 hrs. 37 min.	
Jupiter	9 hrs. 50 min.	
Saturn	10 hrs. 14 min.	
Neptune	15 hrs.	
Uranus	10 hrs. 45 min.	Clockwise
Venus	unknown	unknown
Pluto		

Here are the rotation periods of the planets. Only Uranus is known to rotate clockwise. Very little is known about Venus and Pluto. 17

Frame 17, Revision

Table 27 reports the proportion of students selecting various alternatives on Test item 27.

TABLE 27
Percent Choosing Various Responses to Item 27

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	11	16	10	11	2	8
2	38	48	59	52	53	69*
3	31	15*	14	15	17	8
4	20	21	17	21	28	15

*Significant at the .05 level

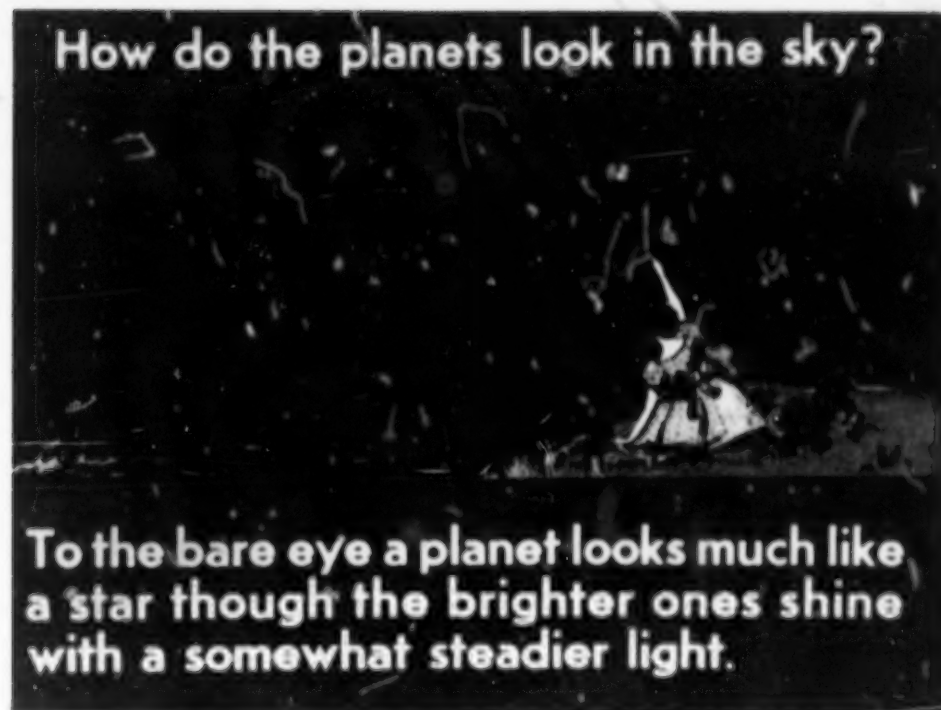
Only the tenth graders were able to answer Item 27 correctly in the majority of cases, and then only those who saw the revised filmstrip. Tenth graders who saw the original filmstrip made the mistake which was most commonly made by all other grade groups; namely, indicating that Mercury rather than Jupiter has the shortest rotation period. There were no significant differences among students in grades five, six, and seven with respect to the wrong answers that they chose, except that the fifth and sixth graders who saw the original were somewhat less likely to choose Uranus as having the shortest rotation period.

Frames 18 and 19 form a sequence which communicates the information that planets appear to have a relative motion among the stars and that this relative motion is the only sure way of identifying planets by observation with the unaided eye.

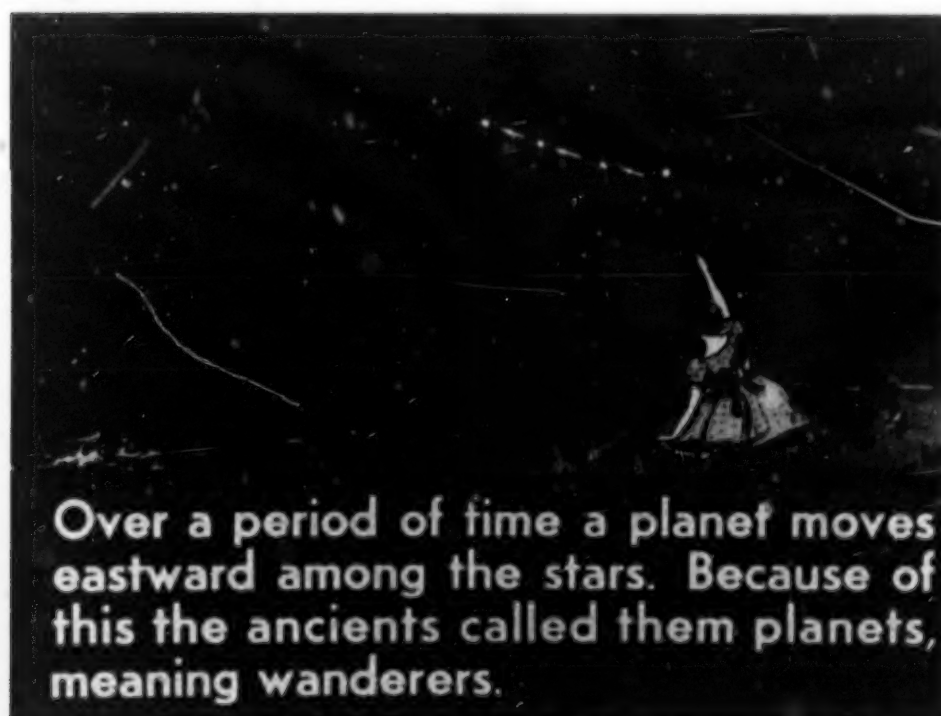
In the original filmstrip a caption on Frame 18 indicated that the planets look much like stars to the bare eye, but that the brighter planets shine with a somewhat steadier light. In the revision the idea of the steadier light was omitted since there is some question as to the validity of this distinction.

Frame 19 in the original had a new caption but the pictorial element was identical to Frame 18 in every respect except that what appeared to be four planets connected by straight lines was in the representation of the sky, whereas only one had appeared in the original frame. The object, obviously, was to indicate apparent relative motion. This motion was indicated in the revised filmstrip by using a label of January 1 to show the location of the planet on that date in Frame 18 and then the use of the label January 30 to show the changed location on that date.

The caption on original Frame 19 included a statement that the relative motion of the planet among the stars is in an Eastward direction and that this motion caused the ancients to call the planets "the wanderers". This latter bit of gratuitous information was omitted from the revision. In its place, the viewer was oriented by a caption stating that the person in the picture was facing south and that the planet was moving toward that person's left; that is, to the East.



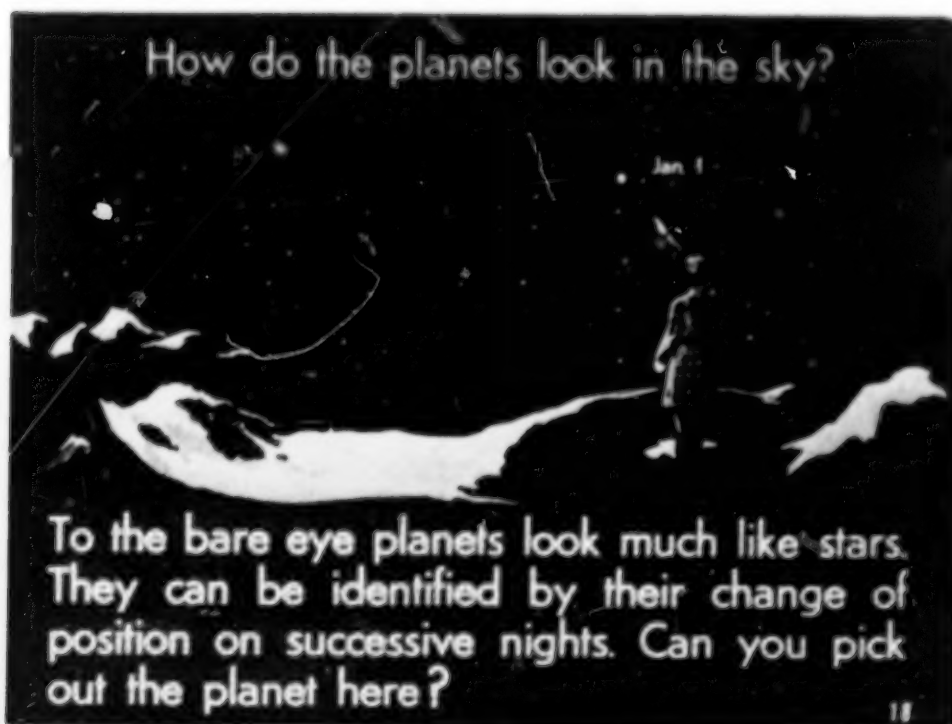
Frame 18, Original



Frame 19, Original



Frame 18, Revision



Frame 19, Revision

Test items 28 and 29 were related to information presented in the two frame sequence, Frames 18 and 19. The two items approached the information from different ways. Item 28 asks the student to select the statement that correctly indicates how one can tell the difference between a planet and a star.

28. How can you tell the difference between a planet and a star?

1. stars are in the same relative position every night
2. stars have a slightly different color
3. stars become brighter during a full moon
4. stars are brighter than planets

Test item 29 gets at the motion of the planets in somewhat more concrete terms, in that it sets up a hypothetical situation and requires the student to identify the appropriate response to the situation by applying information presented in the filmstrip.

29. At 9 P.M. on March 1, you see the planet Jupiter as you face straight south. If you look again on April 1 at the same time, where will you see Jupiter?

1. at exactly the same place where you saw it before
2. closer to the western horizon than where you first saw it
3. to the left of where you first saw it
4. to the right of where you first saw it

Table 28 shows that there were no significant difference among groups of students who saw the alternative versions in terms of their responses to Item 28. Only in the case of the tenth graders did the majority of students respond correctly to this item. Among students in grades five through seven, approximately as many as agreed that stars are brighter than planets as selected the correct answer; namely, the stars are in the same relative position every night. In these grades there was a slight but not statistically significant difference in favor of the revised filmstrip.

TABLE 28
Percent Choosing Various Responses to Item 28

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	35	38	39	50	71	70
2	14	4	12	8	7	2
3	20	15	7	10	0	3
4	31	43	42	32	22	25

In contrast to the results found from Item 28, responses to Item 29 showed consistent and statistically significant differences in favor of the groups who saw the revised filmstrip.

TABLE 29
Percent Choosing Various Responses to Item 29

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	22	9	17	4	9	7
2	35	25	28	33	22	16
3	21	43**	28	46*	38	64**
4	22	23	27	17	31	13*

*Significant at the .05 level

**Significant at the .01 level

While less than half of the students responded correctly to Item 29 except for the tenth graders who saw the revised filmstrip, statistically significantly smaller proportions answered the question correctly who had seen the original filmstrip. There seemed to be no consistent pattern with respect to the selection of incorrect responses, except that the tenth grade students who saw the original filmstrip were somewhat more disposed to select the fourth alternative, which would indicate that they may have interpreted the original frame as showing a left to right motion of the planets.

Frame 20 is a "split frame" intended to show that Mercury and Venus appear as evening stars just before sun set and as morning stars just before dawn. In the original, the drawings showed the sun just over the horizon on the right side of the left hand frame, indicating sun set and the evening star. The sun was shown to the left side of the right hand frame, indicating dawn and morning star. In the revision, the morning star was shown in the left frame and the sunrise was shown at the far left as it would be seen by an individual facing South in the Northern hemisphere. The right hand side of the frame showed the evening star with the sun setting at the right, again as it would be seen by an observer facing South in the Northern hemisphere.

Test item 30 is related to the content of Frame 20.

30. Mercury and Venus are seen only near the sun either at dawn or at sunset because:

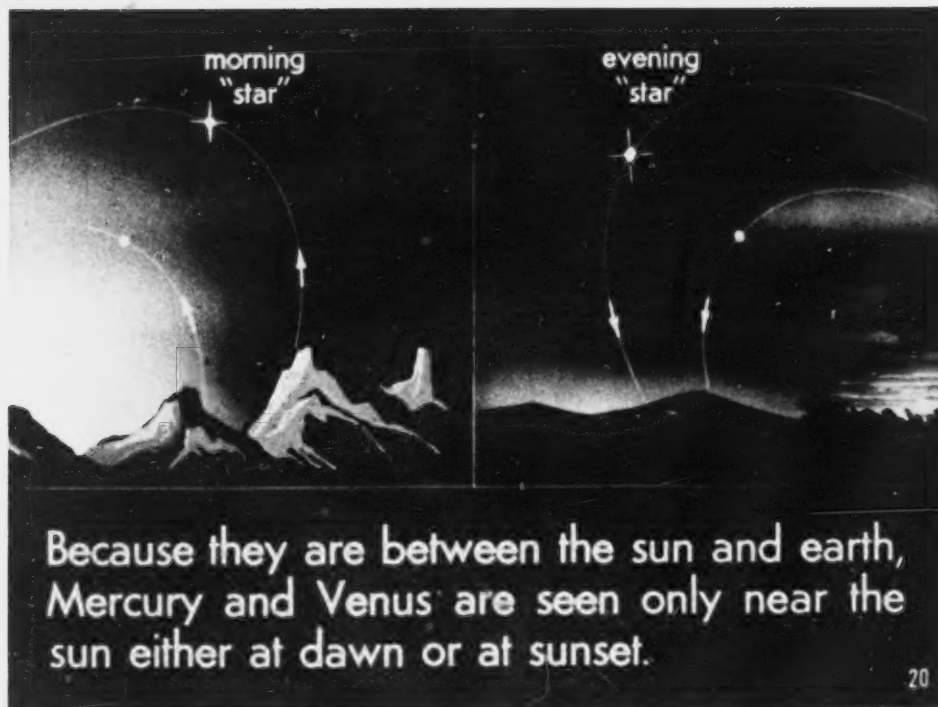
1. they are too dim
2. at that time they are not hidden by clouds
3. they are moving too fast
4. they are between the sun and earth

As can be seen from Table 30, no significant differences in proportions passing Item 30 were observed between the group seeing the original and revised frames. More than two out of three students were able to answer the item correctly regardless of the version of the filmstrip that they saw.

TABLE 30

Percent Choosing Various Responses to Item 30

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	8	12	17	13	6	8
2	21	21	10	13	7	10
3	7	5	4	6	2	8
4	64	62	69	69	85	74

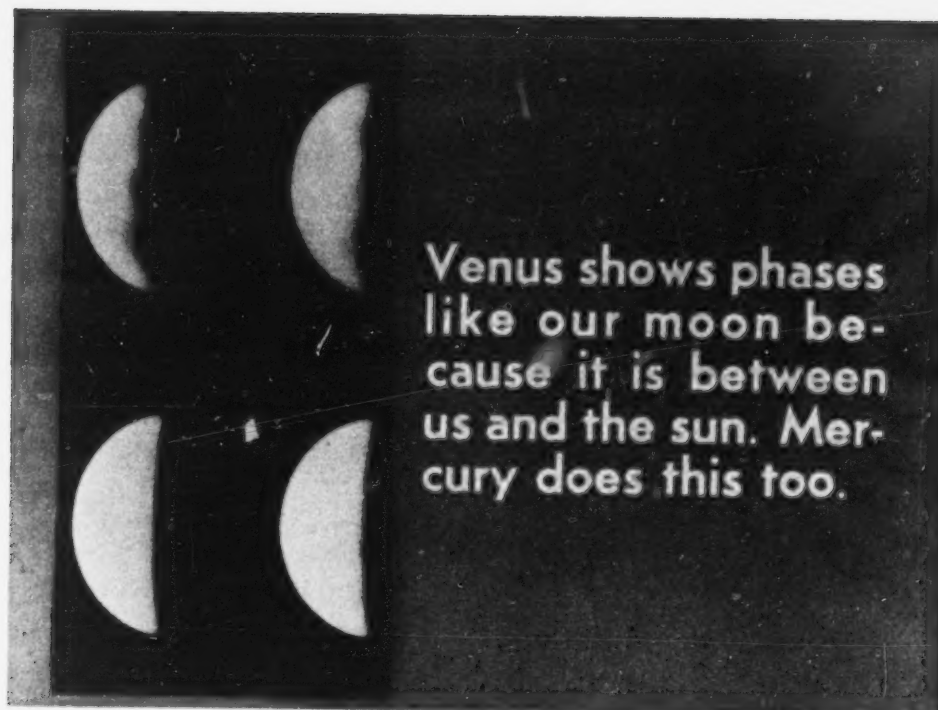


Frame 20, Original

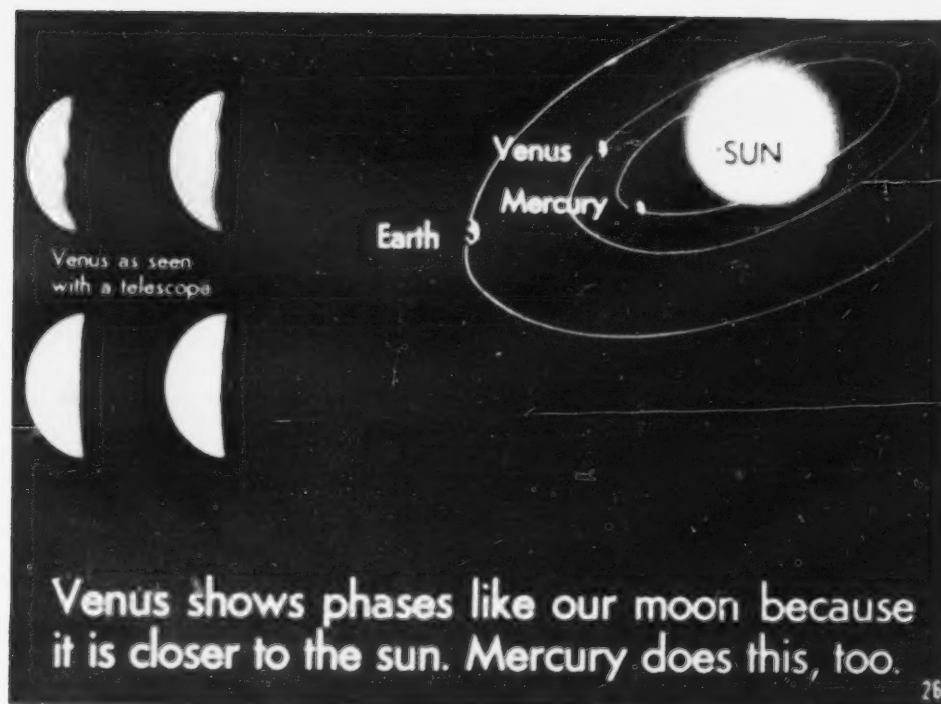


Frame 20, Revision

Frame 26 in the revised filmstrip follows the frame in which the information about the appearance of Mercury and Venus as evening stars was given. In the original filmstrip, this frame was introduced four frames later, following frames concerning the ecliptic and the appearance of certain planets as seen through a telescope. In addition to this change in sequence the frame itself was revised. The drawing of the sun and the orbits of Mercury, Venus and Earth was included in the upper right hand corner of the revised frame. This space had been occupied exclusively by the caption in the original frame. The caption was also changed in the revision by using a more strictly correct statement; namely, that Mercury and Venus are closer to the sun than the Earth rather than that they are between the Earth and the sun. In both frames telephotographs of Mercury showing four phases occupy the left side of the frame. In the case of the original, however, these telephotographs were larger.



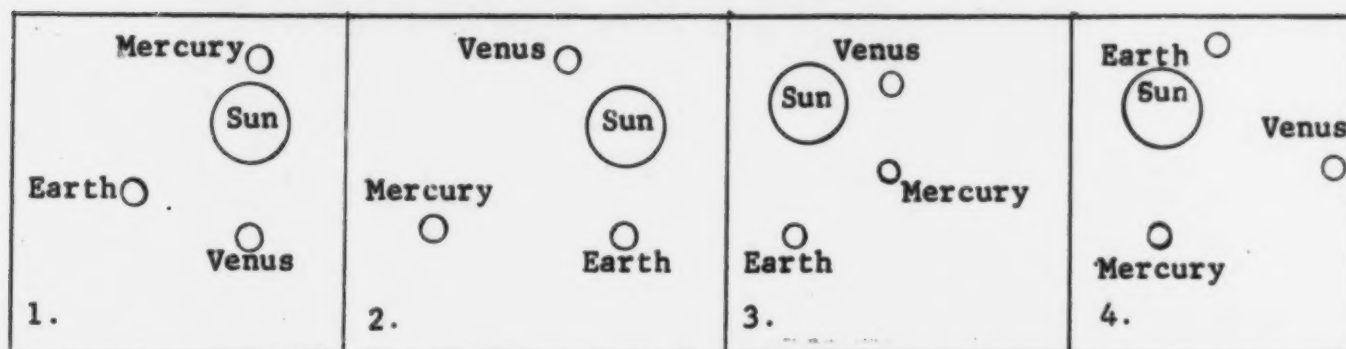
Frame 26, Original



Frame 26, Revision

Test 38 related to the reason why Mercury and Venus show phases.

38. Mercury, like Venus, shows phases like our moon. The reason for this is because the positions of the earth, sun and Mercury are like one of the figures shown below. Which one:



As can be seen by Table 31, the revisions did not result in significantly greater proportions of students selecting the appropriate response to Item 38.

TABLE 31

Percent Choosing Various Responses to Item 38

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	31	31	54	47	52	53
2	19	24	16	18	17	13
3	25	32	22	19	12	23
4	25	13	8	16	19	11

It would appear from the results that fifth and sixth graders did not generally grasp the information about the phases of Venus and Mercury. Only about half of the seventh and tenth graders responded correctly to the item, too.

Frame 21 was a continuation of information concerning Mercury and Venus. This frame was not changed; that is, it is the same in both the revision and the original filmstrip.

Table 32 shows, as expected, that the responses to the item testing information on this frame were not statistically significantly different for the two groups seeing the alternative filmstrips.

31. When "West" of the sun Mercury and Venus rise before the sun and are seen as:

1. evening "stars"
2. moons
3. morning "stars"
4. comets

TABLE 32

Percent Choosing Various Responses to Item 31

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	36	36	28	30	14	25
2	4	3	1	4	2	3
3	59	50	70	58	84	72
4	1	11	1	8	0	0

Frames 22 and 23 deal with the ecliptic -- the path followed by the sun, moon and planets across the heavens. Also contained in these two frames is the information concerning which planets are visible to the unaided eye and which can be seen only with the telescope.

In essence, the revision separated these two bits of information into two separate frames, whereas, in the original, the information was given in an intermingled form in the captions of two frames that were otherwise identical; that is, Frame 22 and Frame 23 of the original had identical pictorial elements but differed in their captions.

The revision emphasized the term ecliptic by one caption which included in capital letters, "This path is called the ecliptic". Also, a label appeared on Frame 22 of the revision noting that the ecliptic is the path of the sun, moon and planets. Frame 23 of the revision was similar, in pictorial content, to the frames of the original, except that the ecliptic was outlined higher on the frame to give the more accurate impression as to where it is located when observed by a viewer in the north temperate zone.

Three test items were used to refer to the two frame series just described. Item 32 deals with the concept of ecliptic but does not mention it by name.

32. As they appear to cross the earth's sky,

1. all planets follow the same path as the moon and sun
2. all planets follow somewhat different paths
3. all planets follow the same path, but a different one from that followed by the sun and moon
4. some planets follow one path and some follow another

Items 33 and 34 constitute two approaches to testing the students' knowledge of the information as to which planets can be seen only by telescope and which can be seen by the naked eye.

33. At night Uranus, Neptune, and Pluto can be seen:

1. by the bare eye
2. by looking thru colored glass
3. only with a telescope
4. not at all

34. Which of the following planets can be seen without the aid of a telescope?

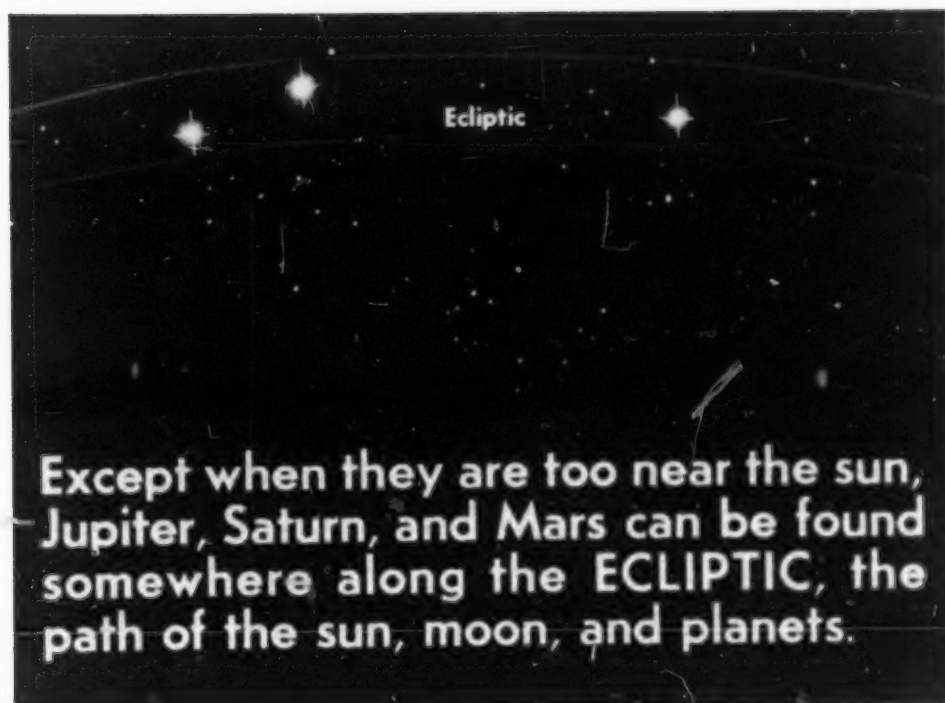
1. Uranus
2. Mercury
3. Neptune
4. Pluto

Table 33 shows the proportions selecting alternative responses to Item 32. It will be observed that the group seeing the revised filmstrip did significantly better on this item at the tenth grade level, and consistently but not significantly better at the level of grades five, six, and seven.

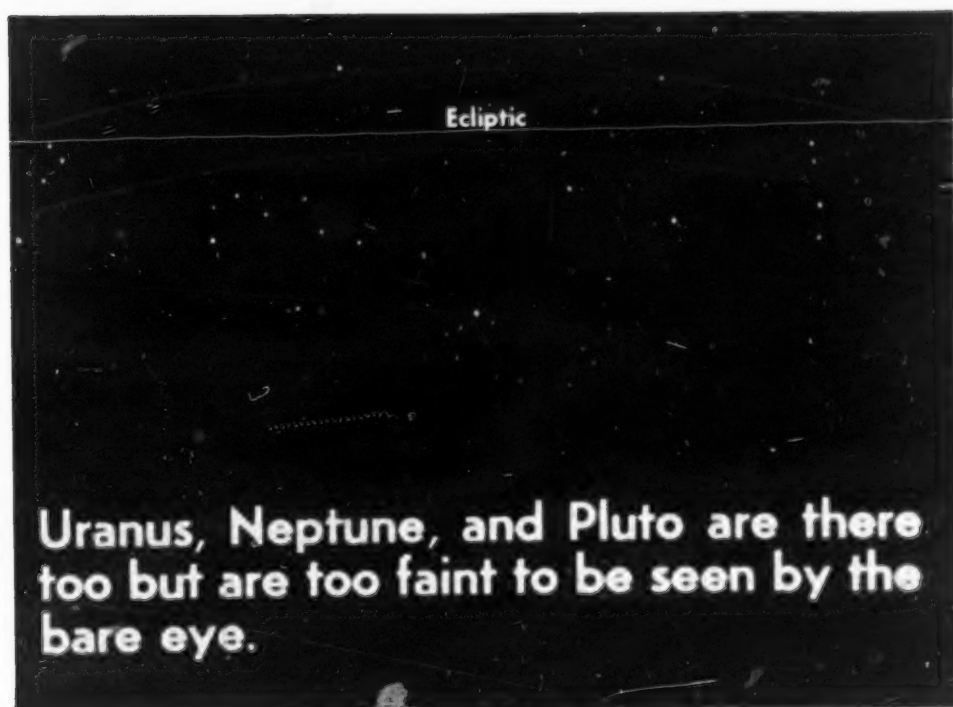
TABLE 33
Percent Choosing Various Responses to Item 32

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	15	26	34	44	31	46*
2	33	31	25	29	42	26*
3	21	24	22	16	11	15
4	31	19	19	11	16	13

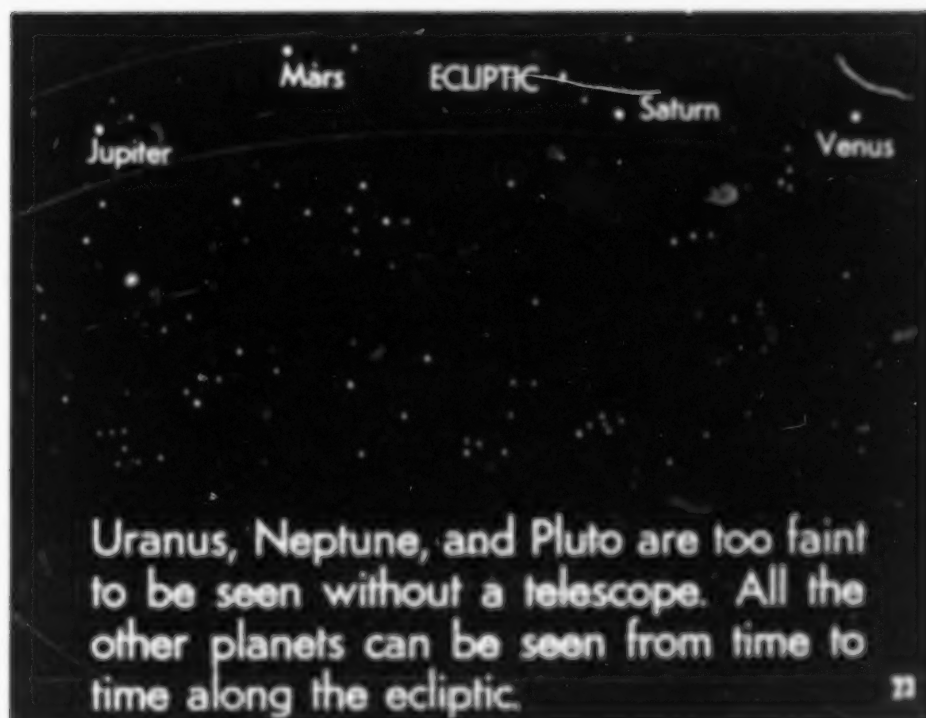
*Significant at the .05 level



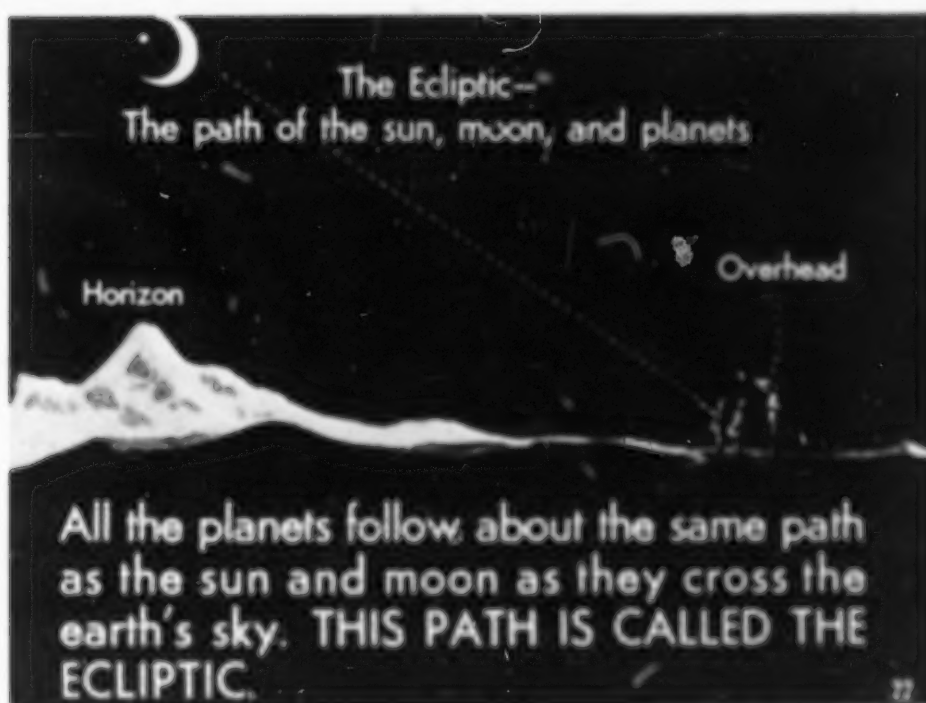
Frame 22, Original



Frame 23, Original



Frame 22, Revision



Frame 23, Revision

Tables 34 and 35 show no significant differences among the groups with respect to their ability of identify planets which can and which cannot be seen without the aid of a telescope.

TABLE 34
Percent Choosing Various Responses to Item 33

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	22	11	15	18	5	7
2	0	3	1	7	3	3
3	64	68	67	58	71	63
4	14	18	17	17	21	27

TABLE 35
Percent Choosing Various Responses to Item 34

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	9	13	14	11	15	11
2	56	50	56	65	72	72
3	19	19	19	11	8	10
4	16	18	11	13	5	7

Frame 24 is a photograph of a group of children who are looking at a planet through a telescope. The only difference made in the revision was to emphasize three key words in the caption by capitalizing them. The three words were "brighten", "magnify", and "really".

Item 35 relates to the action of the telescope in helping us to see the planets.

35. To study the planets a telescope may be used

1. only to brighten the planet images
2. only to magnify the planet images
3. to brighten and magnify planet images
4. to filter out haze and dust that dims planet images

Table 36 shows that a significantly higher proportion of students in grade seven were able to pass Item 35 if they had seen the revised filmstrip rather than the original. In grades five, six and ten the differences were not significant.

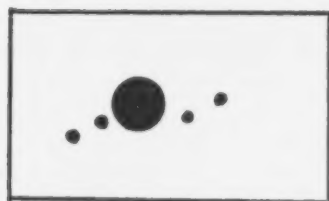
TABLE 36
Percent Choosing Various Responses to Item 35

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	10	13	7	8	2	3
2	18	19	19	8	24	25
3	55	58	67	83*	72	70
4	17	10	7	1	2	2

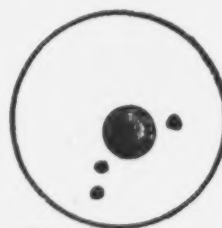
*Significant at the .05 level

Test item 36 was also related to frame 24, but there were no changes in the revision that related to the information necessary to respond correctly to that item.

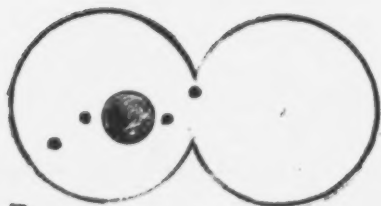
36. Which is most like what you would see if you looked at Jupiter through a telescope?



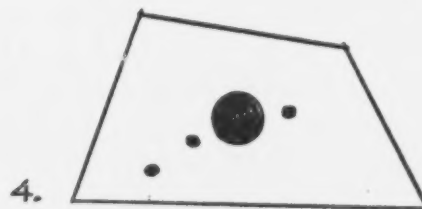
1.



2.



3.

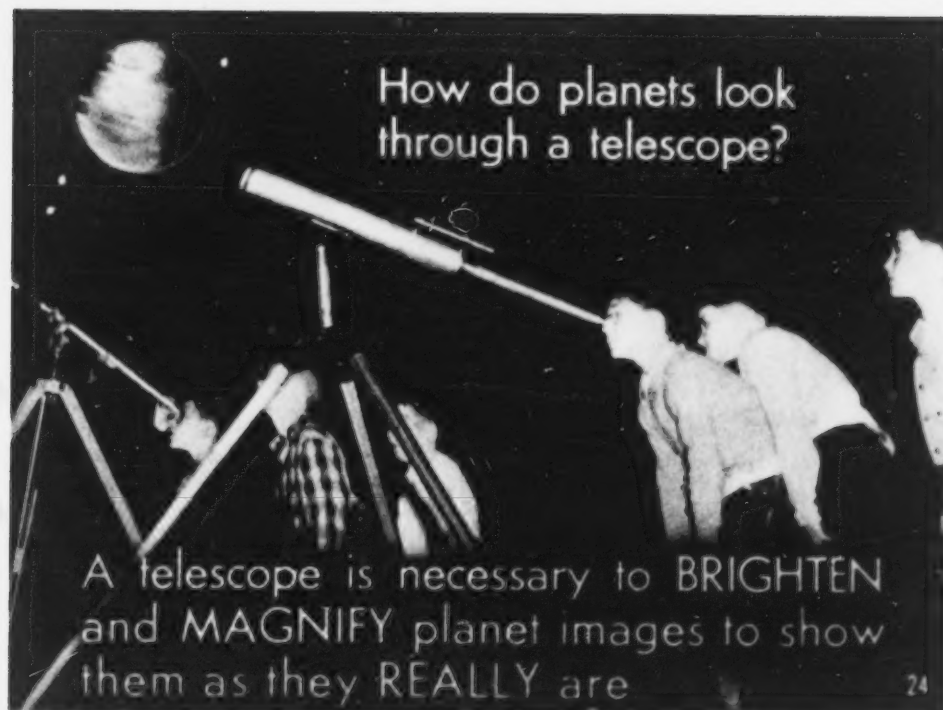


4.

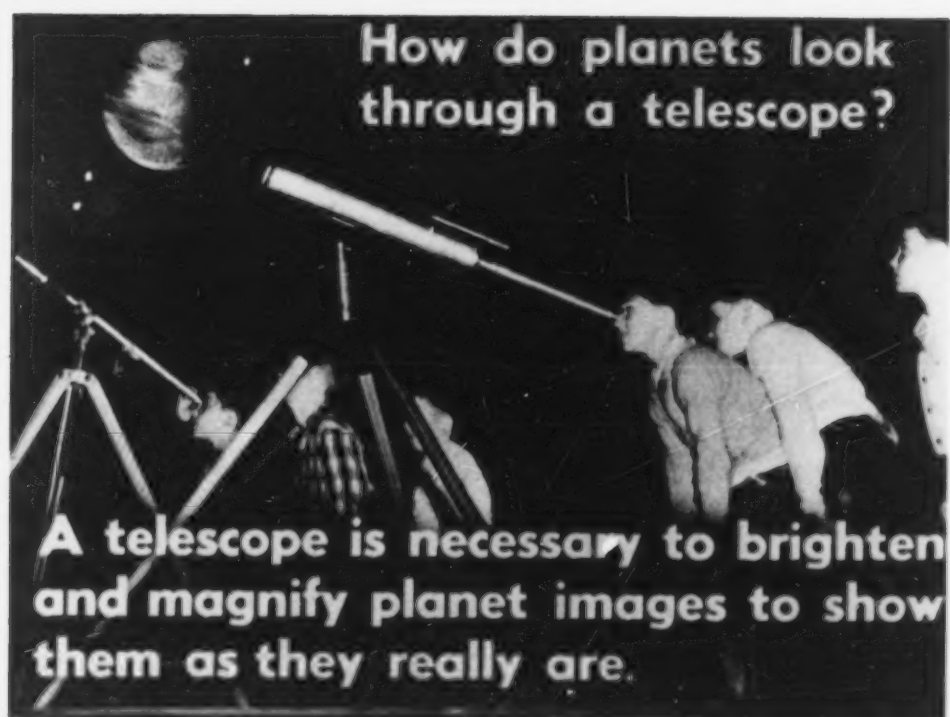
As would be expected, there were no significant differences among the groups with respect to their responses to this item, as shown by Table 37.

TABLE 37
Percent Choosing Various Responses to Item 36

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	21	31	42	30	15	25
2	52	56	46	60	70	56
3	13	7	8	10	9	13
4	14	6	4	0	5	7



Frame 24, Original



Frame 24, Revision

Frame 26 is a telephotograph of the transit of Mercury as it passes across the face of the sun. In the original, there was an unexplained line across the middle of the face of the sun, and a very fine line arrow was used to point out the planet of Mercury which appeared near the top of the sun's disc. Mercury was not labeled. There were additional markings on the sun which probably were sun spots. These were not mentioned. In the revision, Mercury was labeled, the arrow pointing to it was enlarged, and the sun spots were labeled as such.

Item 37 required the students to select the drawing which most nearly represented the transit of Mercury as shown in the filmstrip.

37. From earth we can see Mercury as it passes across the face of the sun. Which drawing most nearly represents this?

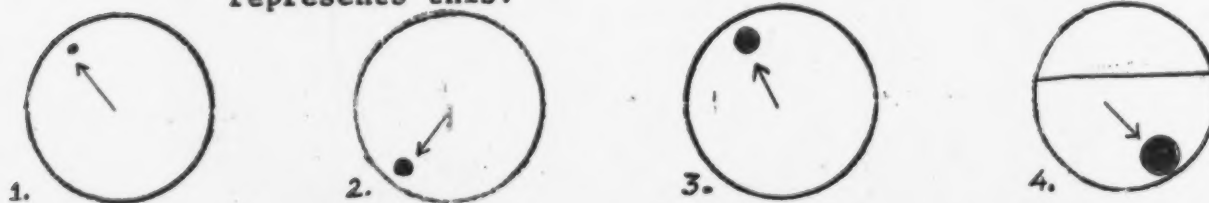
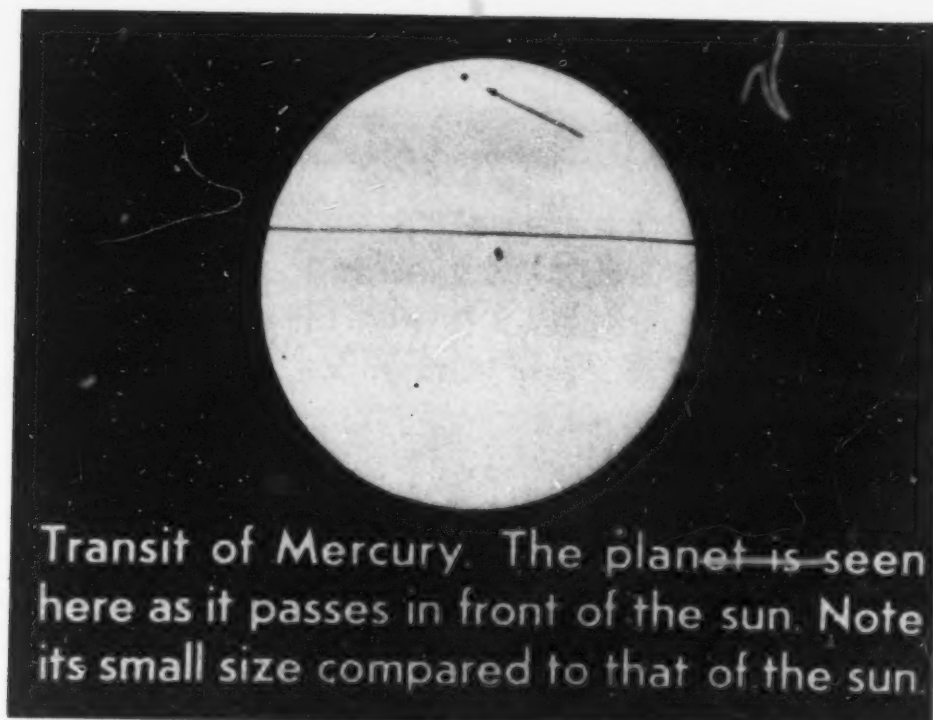
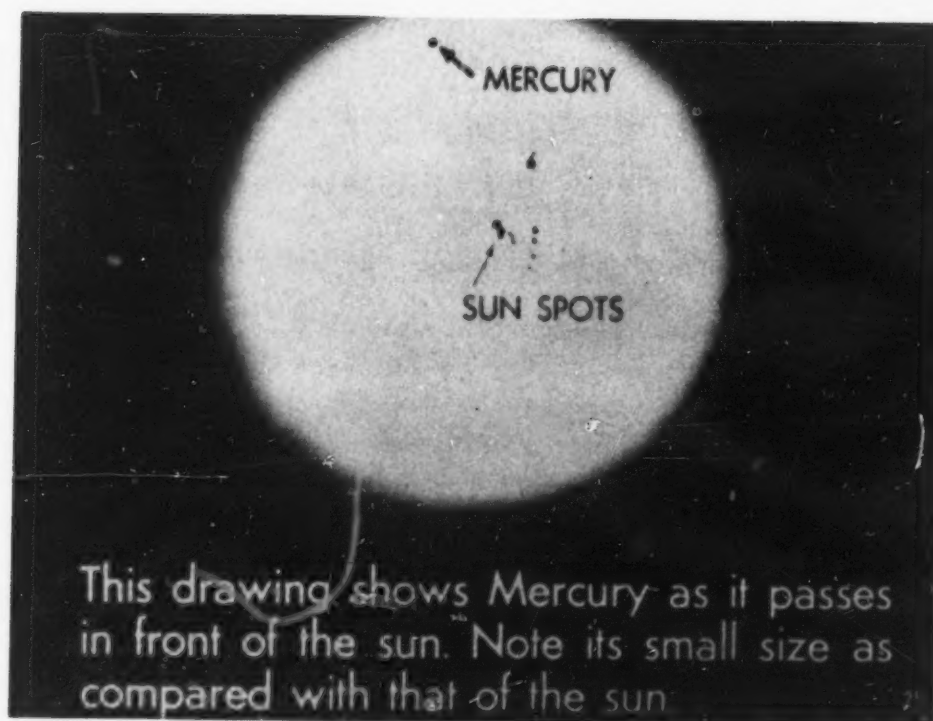


Table 38 shows that there were no significant differences between the two groups in terms of their responses to Item 37. It was interesting to note, however, that choice number 4, in spite of the disproportionately large size of the object identified as Mercury was selected by consistently though not statistically significantly fewer students who saw the revised version. This was the choice that had the extraneous horizontal line which was shown in the original filmstrip and was not explained in that filmstrip.



Frame 25, Original



Frame 25, Revision

TABLE 38

Percent Choosing Various Responses to Item 37

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	46	53	53	54	68	64
2	8	10	10	11	6	13
3	13	16	13	18	7	15
4	33	21	24	17	19	8

A series of frames showing telephotos of the planets was begun with one showing Mars. In the original, the caption identified Syrtis major and a polar icecap. In the revision, the same caption was supplemented by labels opposite these features, superimposed on the telephotograph with arrows pointing to these distinctive features.

Test items 39 and 40 both referred to Frame 27. Test item 39 required the students to select the drawing that was most similar to the picture shown in the filmstrip.

39. Do you remember seeing a picture of Mars in the filmstrip? What outstanding features do you remember:



It will be noted that choices one and three are quite similar in appearance. Choice three, however, has a small irregularity at the upper right hand portion of the diagram and includes three small dots. This distractor was included to determine the extent to which the students would select the distractor which might suggest the polar icecap which was identified on the revised filmstrip by an arrow and a label at almost the identical point on the photograph.

Test item 40 required the students to recall that a characteristic feature of Mars was the polar icecap. It will be noted that Test item 40 is entirely verbal.

40. In the filmstrip Mars was shown to have an important characteristic structure. What was it?

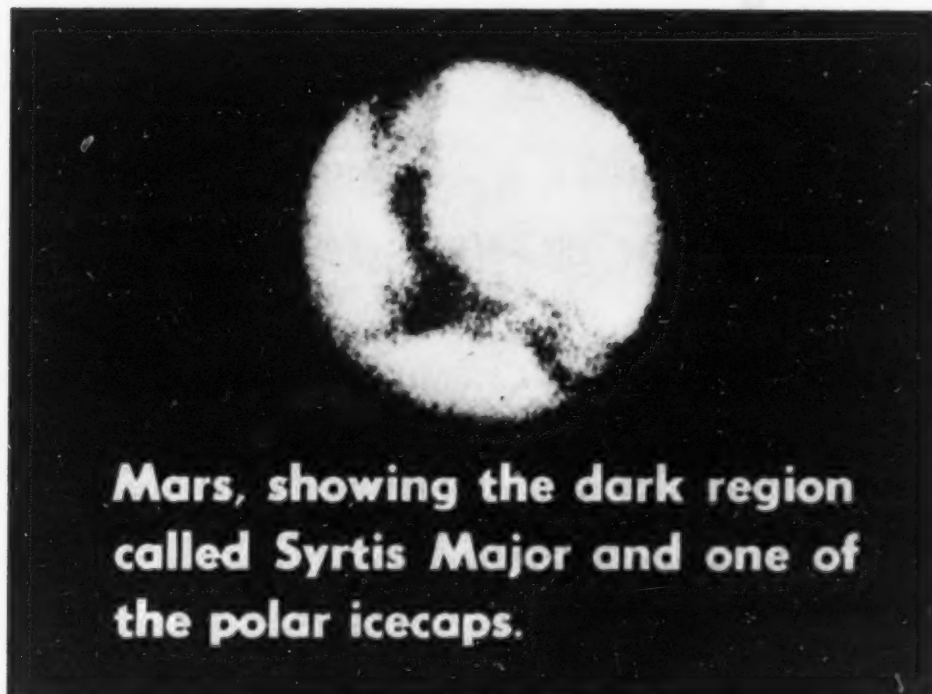
1. no vegetation
2. clouds bands
3. polar icecap
4. no desert area

Table 39 reports the statistics on students' responses to Test item 39. It will be noted that students who saw the revised filmstrip did indeed consistently (and in the case of the seventh graders statistically significantly) more frequently give the right response for Test item 39. It is also interesting to note that the error of selecting response number three was consistently more frequently made by students who saw the original filmstrip than by those who saw the revision. In the case of seventh and tenth graders, this difference was statistically significant.

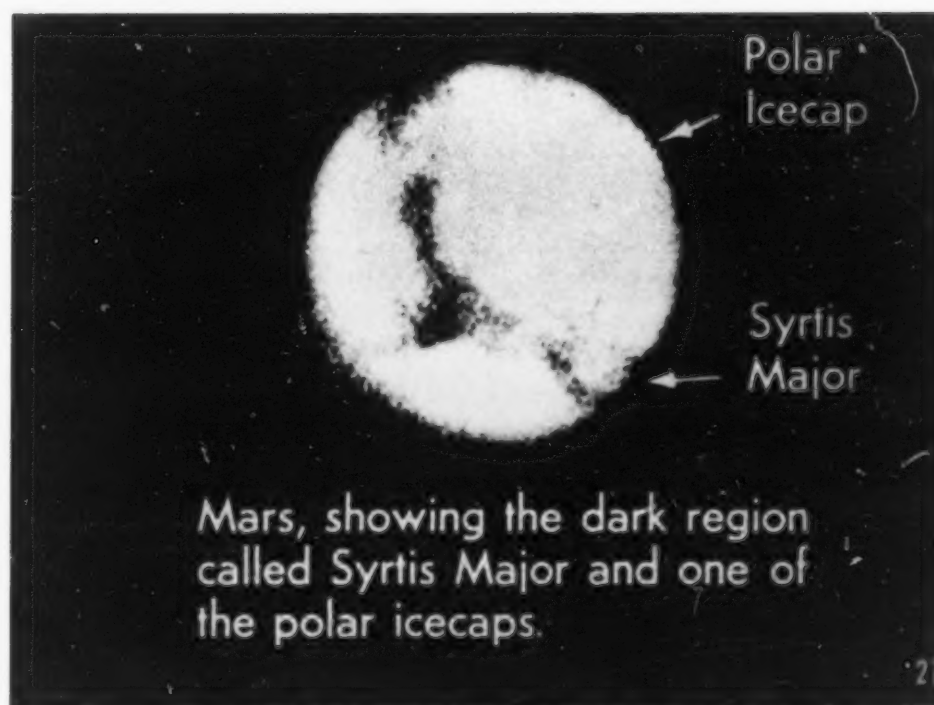
TABLE 39
Percent Choosing Various Responses to Item 39

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	18	27	20	38*	17	30
2	29	25	29	17	24	21
3	36	29	41	25*	45	28*
4	17	19	10	20	14	21

*Significant at the .05 level



Frame 27, Revision



Frame 27, Original

Table 40 shows that there were no significant differences in the proportions of students who recalled that the polar icecap was a distinctive feature of Mars. For some reason, however, a greater proportion of those who saw the original filmstrip responded correctly to the item, but this difference was not statistically significant.

TABLE 40
Percent Choosing Various Responses to Item 40

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	14	22	14	14	8	13
2	15	22	21	28	22	20
3	64	49	59	54	70	60
4	7	7	6	4	0	7

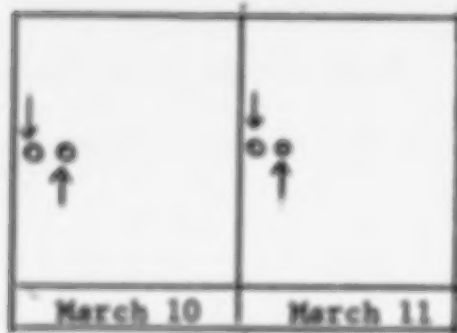
The remaining frames of the sequence of telephoto views of the planets were not modified, hence test items included on the examination are not reported here, nor are the responses of the students. In general, of course, the variations in responses to these items could be attributed to chance. The test items may be examined by referring to the test which appears as Appendix B.

Frame 32 was intended to show the motion of Pluto among the fixed stars. It was a split frame with an arrow pointing to Pluto as seen on March 10 and March 11, 1934. In the original, a single arrow identified Pluto in each frame. In the revision a pair of arrows was used, one designating a certain fixed star and the other designating Pluto. These arrows were labeled "Pluto" and "star", respectively. The original frame had no labels.

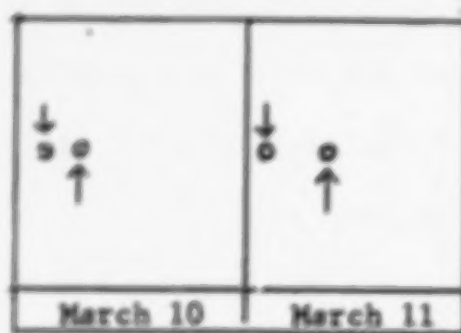
The caption was also changed in the revision with the intention of making the language more directive. In the original, the first part of the caption said, "Pluto showing its change of position in among the stars in one day". In the revision the corresponding part was "Notice how Pluto has moved from the fixed star in just one day".

Test item 45 was employed to give the students an opportunity to show their understanding of the motion of Pluto among the fixed stars.

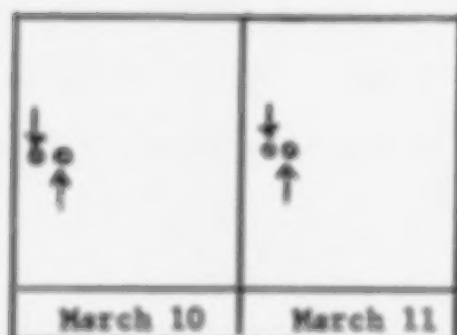
45. Which shows most accurately the extent to which Pluto appears to move away from a fixed star in one day?



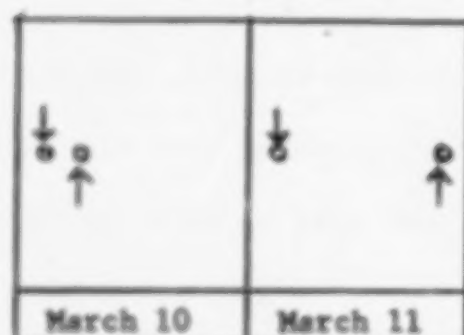
1.



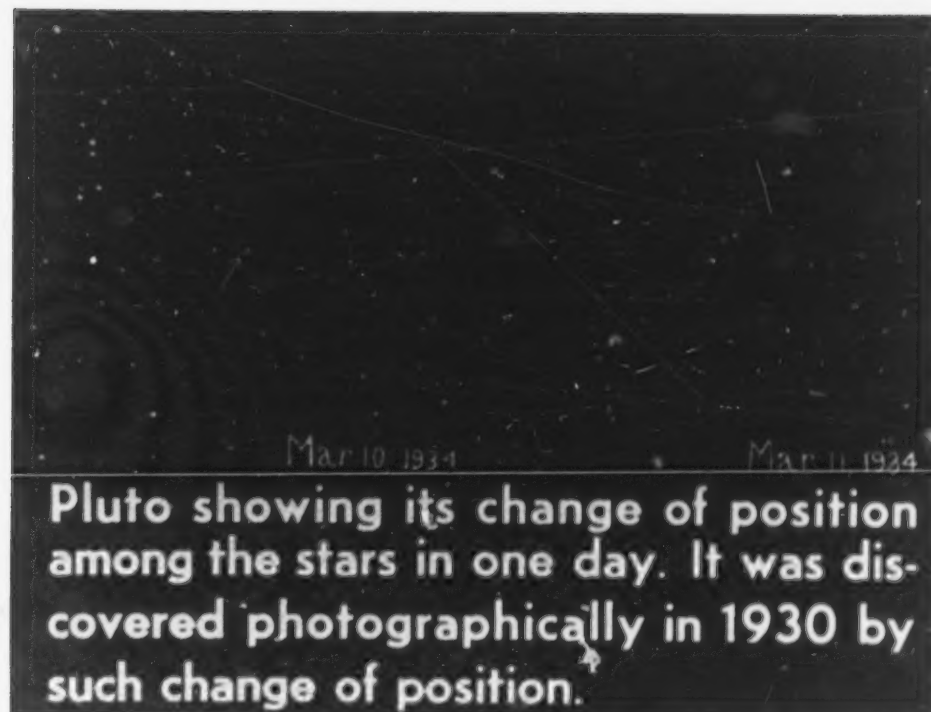
2.



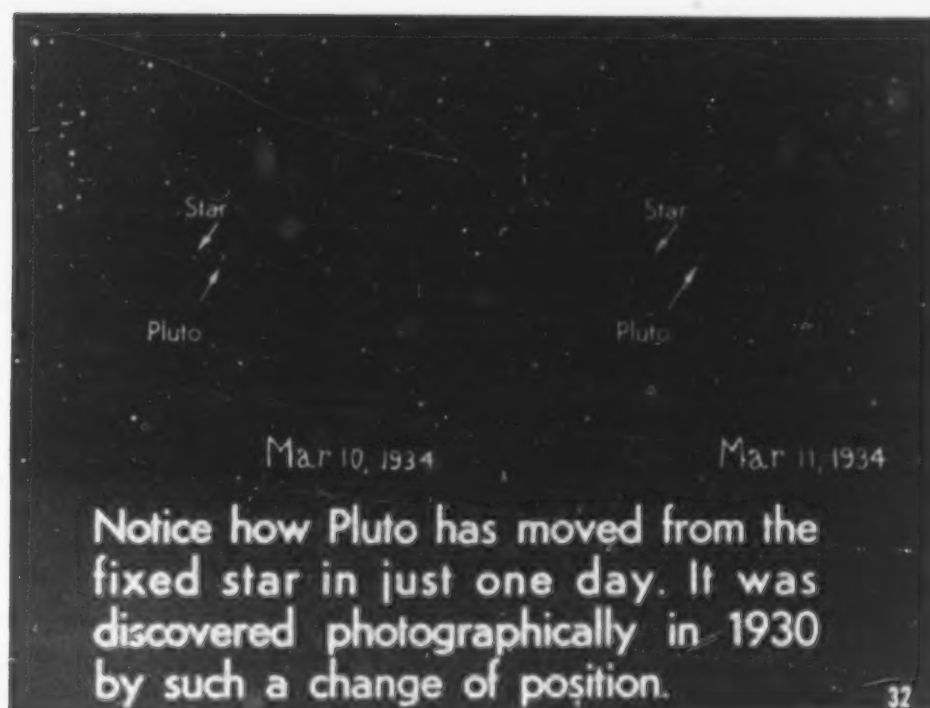
3.



4.



Frame 32, Original



Frame 32, Revision

Table 41 shows the students responses to Item 45. Significant differences in favor of the revision were found at all grade levels.

TABLE 41
Percent Choosing Various Responses to Item 45

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	14	13	6	14	19	11
2	37	62**	32	60*	47	74**
3	25	13	32	12**	24	3**
4	24	12	30	14*	10	12

*Significant at the .05 level

**Significant at the .01 level

The differences were significant at the one percent level in grades five, six, and 10 and at the five percent level at grade seven.

It is interesting to note that in three of six comparisons involving proportions selecting responses that either over estimated or under estimated the relative motion of Pluto in one day, significant differences were found in favor of the revision.

Interviews with elementary grade children who had seen the original filmstrip in the course of a previous investigation indicated that a small proportion of them viewing Frame 34 thought that they were viewing a stylized picture of the surface of Venus. Accordingly, in the revision the landscape in the picture was made more earth-like, with trees and shrubs in the foreground. Also, a label was put on the object in the sky that was represented as Venus. The caption was changed by omitting the astronomers symbol for Venus, and the three sentences of the original caption were changed to one simple sentence and one compound sentence in the revision.

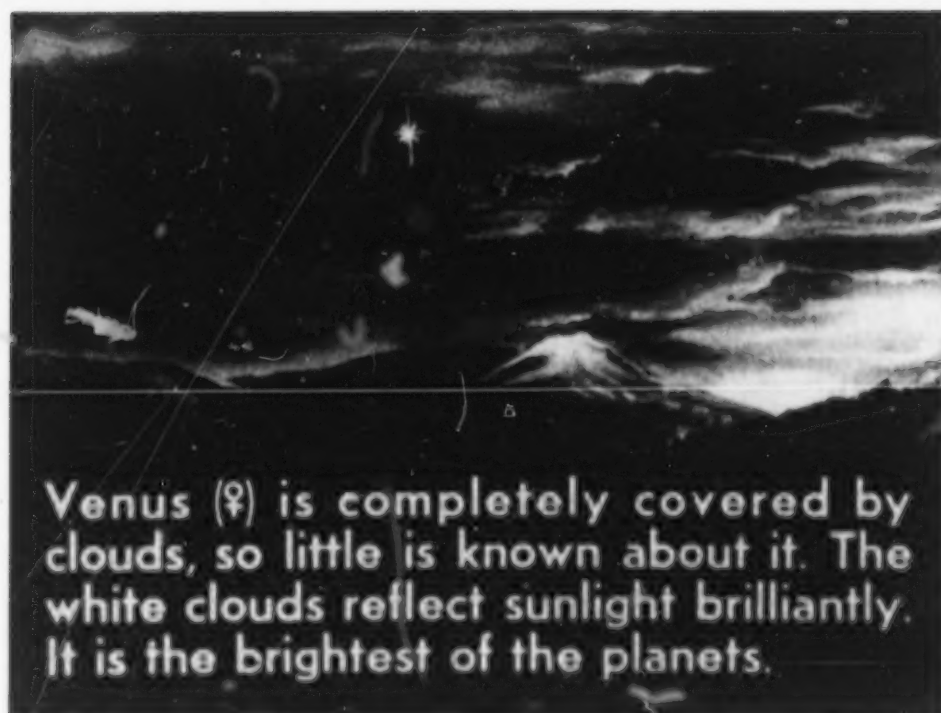
Test item 47 required the students to identify one true statement about Venus.

47. Venus is completely covered by clouds, and so very little is known about it. We do know that it
1. has snow-covered mountains
 2. is the fastest moving planet of the inner planets
 3. is larger than our earth
 4. is the brightest of the planets

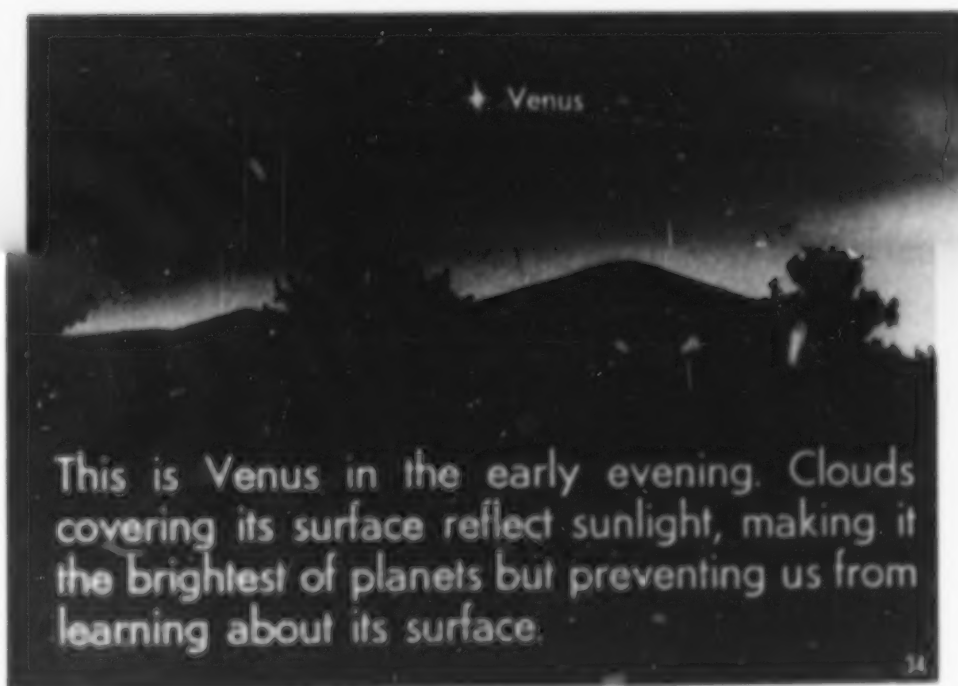
As can be seen from Table 42, no significant differences were found in responses to the Test item 47. Differences approaching the five percent level of significance were found in favor of the original filmstrip the elementary grades and in grade ten. This may be due to the fact that the correct response was incorporated in a single, separate simple sentence in the original, and as a dependent clause as in the revision.

TABLE 42
Percent Choosing Various Responses to Item 47

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	11	13	17	13	3	5
2	21	21	11	16	8	16
3	12	24	22	16	14	18
4	56	42	50	55	75	61



Frame 34, Original



Frame 34, Revision

The only change in Frame 35, which showed a drawing of Mars, was in the placement of labels in the pictorial element and in the last sentence of the caption. In the revision, labels relating to Mars itself were placed up on the left side of the picture and the labels relating to the moons of Mars were placed on the right side. In the original these had been intermingled. In the caption, the statement "It's cool by day and very cold by night", was replaced by the statement "It is always colder than the Earth".

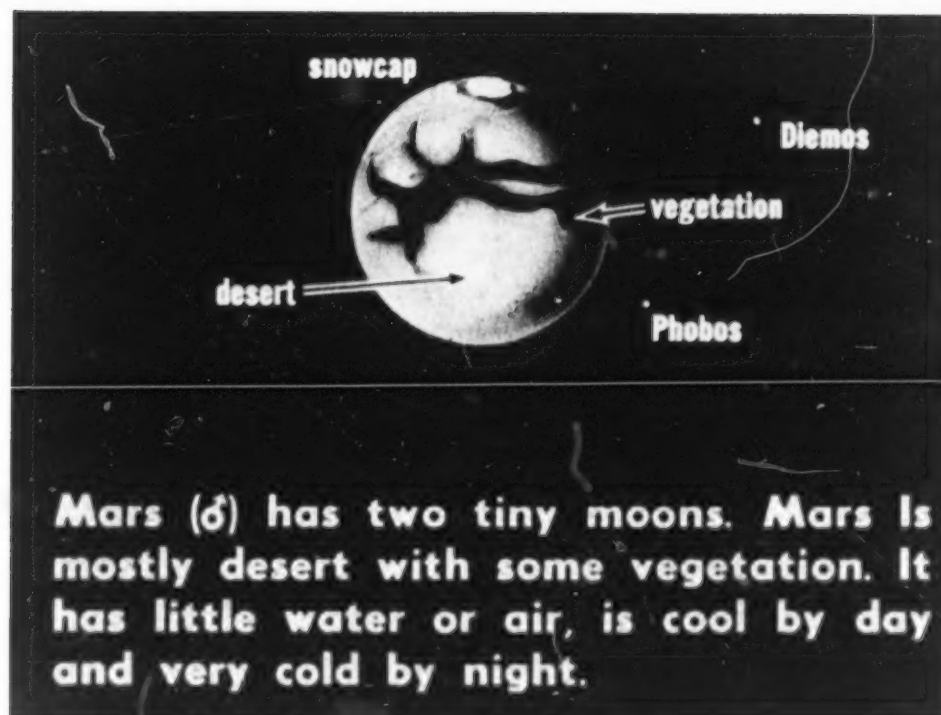
Two test items were written on Frame 35. The first dealt with the condition of the surface of Mars and the second with the temperature of Mars.

48. We know that Mars is

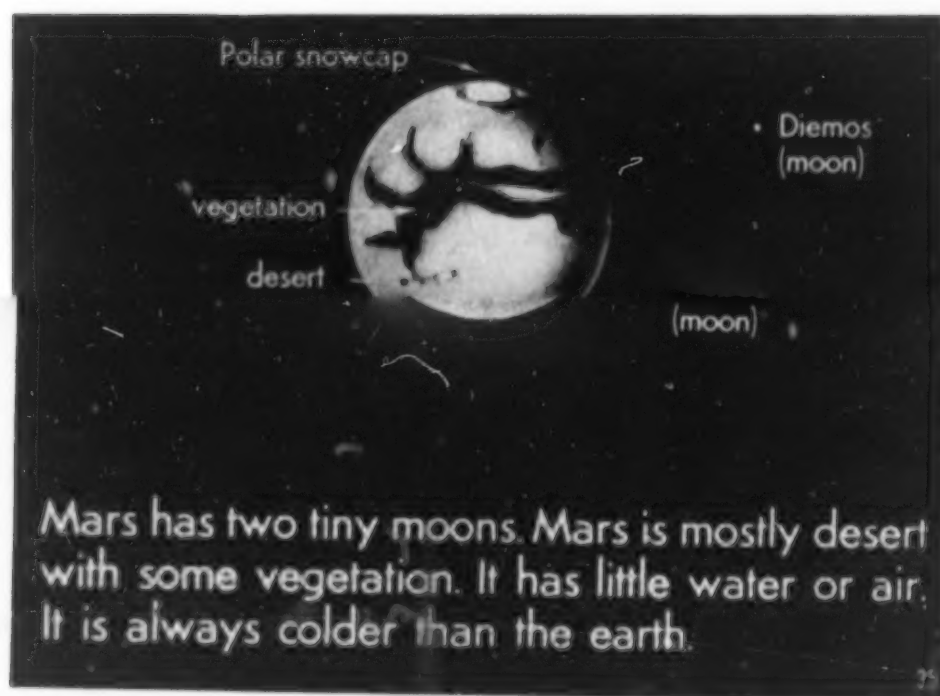
1. completely covered with ice
2. very hot during the day
3. mostly desert with some vegetation
4. nothing but red sand

49. We know that Mars is

1. colder than the earth in winter but warmer in summer
the poles
3. colder than earth at night but warmer during the day
4. always colder than the earth



Frame 35, Original



Frame 35, Revision

Tables 43 and 44 show the student responses to Test items 48 and 49.

TABLE 43
Percent Choosing Various Responses to Item 48

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	3	7	6	10	2	7
2	23	15	12	14	24	12
3	67	72	81	75	67	76
4	7	6	1	1	7	5

TABLE 44
Percent Choosing Various Responses to Item 49

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	19	4	4	6	9	15
2	15	9	14	7	5	13
3	31	19	32	14*	21	12
4	35	68**	50	73**	65	60

*Significant at the .05 level
**Significant at the .01 level

No significant differences were found in connection with Test item 48. The majority of students (at least 2 out of 3) responded correctly. Unaccountably, the most frequent error was in attributing to the surface of Mars a high temperature.

Significant differences in favor of the filmstrip as revised were found in grades five and six in terms of responses to Test item 49. The difference was in the same direction in grade seven, though not statistically significantly so, and there were nearly the same proportions responding correctly for both versions at grade ten. Unaccountably, the most frequently chosen wrong alternative involved attributing high temperature to Mars during the daylight hours. This error was consistently made more frequently by students seeing the original version, and this difference was statistically significant at the seventh grade level.

Frame 36 shows an artist's conception of the planet Mars as mounted on a conventional globe stand. The pictorial element is unchanged in the revision, but the revision does have a caption ~~unchanged in the revision~~, but the revision does have a caption which is so phrased as to emphasize the fanciful nature of the pictorial representation.

Test item 50 gave the students an opportunity to choose between responses that indicated some degree of certainty as to the explanation of the markings on Mars and the response which was correct; namely, that the markings are of unknown origin.

50. Markings can be seen on Mars. They are

1. probably strips of vegetation
2. canals made by intelligent beings
3. of unknown origin
4. optical illusions

Students responses to Test item 50 are summarized in Table 45.

TABLE 45
Percent Choosing Various Responses to Item 50

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	20	19	14	24	15	22
2	41	39	51	43	38	30
3	25	30	27	30	39	48
4	14	12	8	3	8	0

It will be observed that the greatest proportion of students choose the response that the "canals" on Mars are made by intelligent beings. At all grade levels, this choice was more consistently made by students who saw the original filmstrip and the correct response was made consistently by students who saw the revised filmstrip, although none of these differences were statistically significant.

Strange
markings
cross its
surface. Some
consider them
canals and
evidence of
intelligent life,
but there is as
yet no proof
of such life.



Frame 36, Original

This is one man's
view of how Mars
looks. Some think
the markings are
~~canals and evidence~~
of intelligent life,
but there is as
yet no proof of
such life.



Frame 36, Revision

Frame 37 consists of a telephoto view of Jupiter showing four moons. The pictorial element was not modified in the revision, but the caption was. The opening words of the revised caption indicated that the telephoto view as shown was taken through a small telescope, whereas the fact that Jupiter has 12 moons was given first place in sequence in the original caption. This was the third place in the revision. The numbers were arabic number in the original caption (4, 12, etc.) and the numbers were written out in the revision. The word "air" was used in the original film-strip, but the word "atmosphere" replaces it in the revision. The remainder of the caption was the same for both versions.

Two test items were written on Frame 37. The first Number 31 has to do with the atmosphere of Jupiter.

Test item 32 required the students to identify the proper number of moons circling Jupiter.

31. We know that the atmosphere on Jupiter is composed of

1. poisonous carbon monoxide and ethane gas
2. poisonous ammonia and methane gas
4. hydrogen and poisonous methane gas

32. How many moons does Jupiter have?

1. four moons
2. nine moons
3. twelve moons
4. fifteen moons

Table 46 shows the responses to Test item 51. It will be noted that there were no significant differences, except that the students seeing the original version as tenth graders choose the correct response in significantly greater proportion than did those seeing the revision. This is surprising in view of the fact that the stem of the item uses the word "atmosphere" which was the term used in the caption in the revised filmstrip, whereas the word "air" was used instead in the caption of the original filmstrip.

TABLE 46
Percent Choosing Various Responses to Item 51

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	6	16	11	4	5	13
2	56	49	70	72	89	68*
3	14	6	11	4	3	12
4	24	29	8	20	3	7

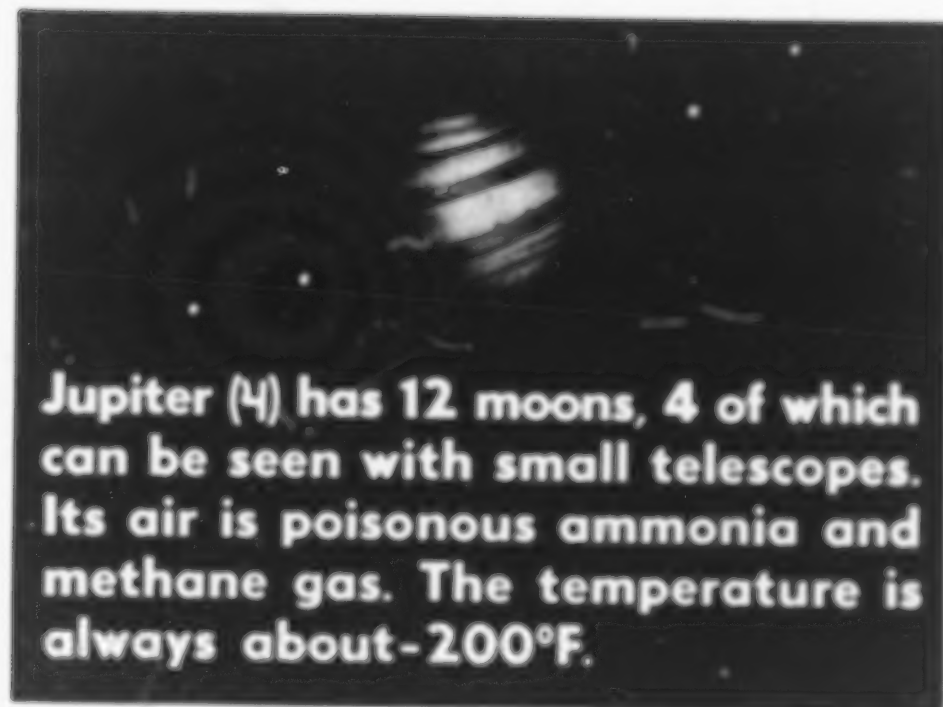
*Significant at the .01 level

Table 47 shows the responses to Test item 52. Significantly greater proportions of fifth, sixth and tenth graders selected the correct response for this item, and the differences were in the same direction although of a non-significant magnitude in grade seven. It should be noted that supporting differences which approach statistical significance are seen in that a consistently greater proportion of students seeing the original filmstrip selected the most obviously erroneous response, namely, four moons.

TABLE 47
Percent Choosing Various Responses to Item 52

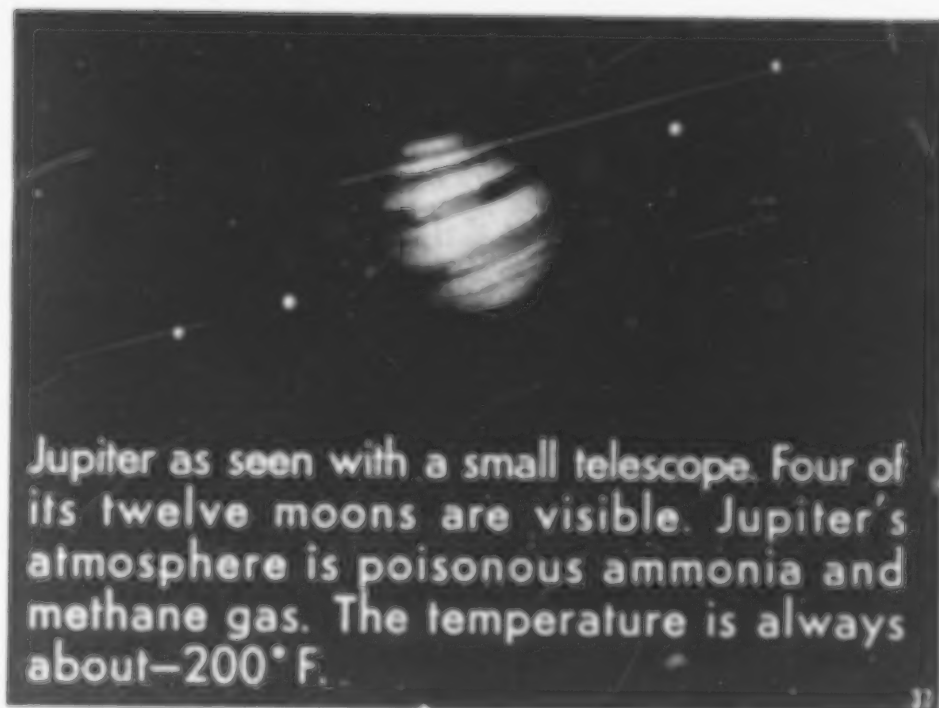
Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	27	16	31	20	29	15
2	34	25	25	34	24	22
3	35	59**	34	39	47	63*
4	4	0	10	7	0	0

*Significant at the .05 level
**Significant at the .01 level



Jupiter (4) has 12 moons, 4 of which can be seen with small telescopes. Its air is poisonous ammonia and methane gas. The temperature is always about -200°F.

Frame 37, Original



Jupiter as seen with a small telescope. Four of its twelve moons are visible. Jupiter's atmosphere is poisonous ammonia and methane gas. The temperature is always about -200°F.

Frame 37, Revision

Two test items approach the matter of the number of moons circling Saturn from two different ways. The first of these, Test item 53, referred the number of moons of Saturn to the number of planets in our solar system. The second, asks students to identify correctly the number of moons Saturn has.

53. It is easy to remember the number of moons circling Saturn because it is the same number as

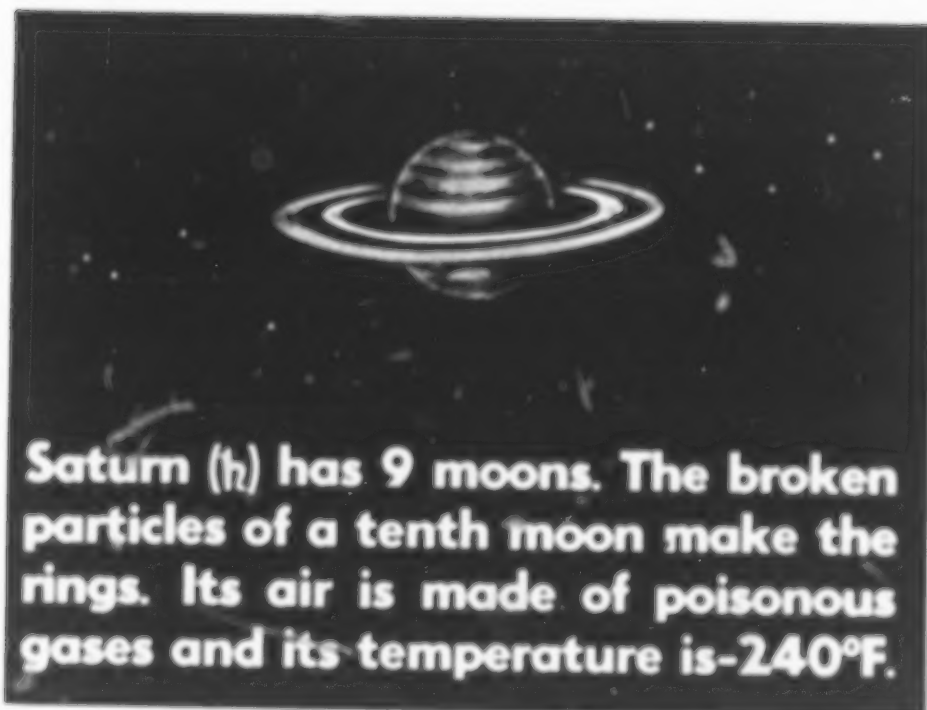
1. the moons of Mars
2. the planets in our solar system
3. the moons of Jupiter
4. the moons of Mercury

54. Saturn has how many moons?

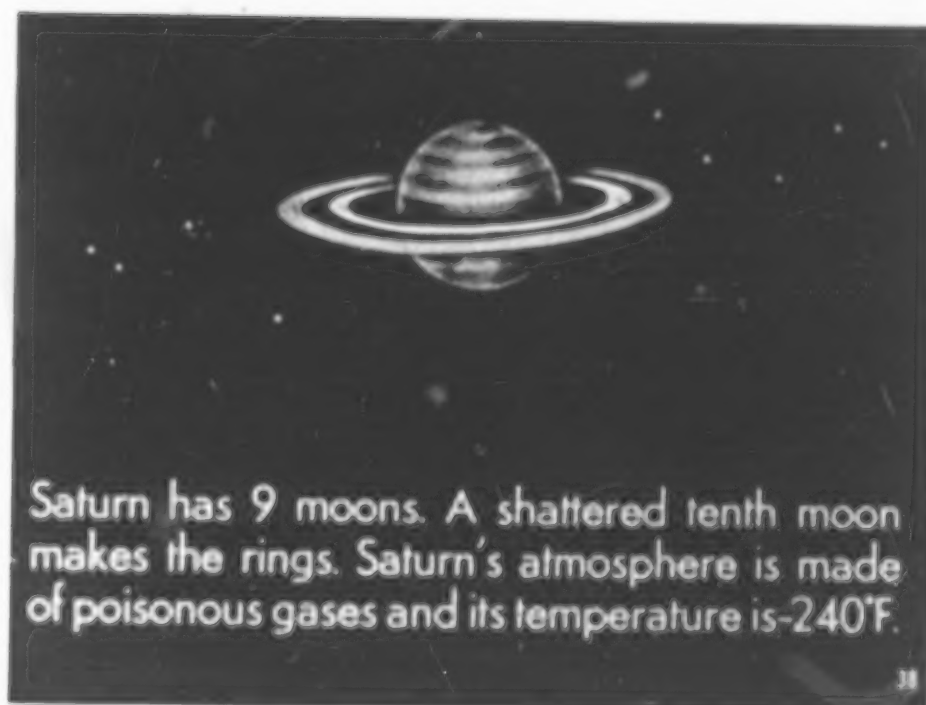
1. two
2. four
3. five
4. nine

Frame 38 is a telephoto of the planet Saturn showing its rings clearly and showing also all nine of its moons.

The pictorial element was not changed in the revision, but the caption was. In the revision, the astronomers symbol for Saturn was omitted. An attempt was made to use stronger language in the caption of the revision by referring to "a shattered tenth moon" instead of "the broken particles of a tenth moon" as appears in the original. Once again the word "air" in the original is changed to "atmosphere" in the revision.



Frame 38, Original



Frame 38, Revision

Tables 48 and 49 show student responses to Test items 53 and 54.

TABLE 48
Percent Choosing Various Responses to Item 53

Choice	Grade 5-6		Grade 7		Grade 10	
	F50	F5R	F50	F5R	F50	F5R
W	72	68	72	71	59	61
1	16	12	7	10	7	12
2	41	46	58	43*	56	65
3	29	24	27	33	20	13
4	14	18	8	14	17	10

*Significant at the .05 level

There are virtually no significant differences in responses to Test items 53 and 54. It will be noted that the single significant difference favored the original filmstrip at the five percent level among the seventh graders. This difference was erased in the case of Test item 54 which covered substantially the same material.

TABLE 49
Percent Choosing Various Responses to Item 54

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	18	16	30	9	14	13
2	23	18	18	19	17	15
3	18	24	11	18	12	20
4	41	42	41	54	57	52

There were only two modifications on Frame 39 which showed Uranus and Neptune with their moons. Labels were added to the revised frame, giving the names of the planets and their surface temperatures. Also, in the revision the astronomers symbols for the two planets were left out.

Test item 55 required the students to indicate which of the alternative choices represented a true statement of the reason for there being no life as we know it on either Neptune or Uranus.

55. Life on Uranus and Neptune would be impossible for several reasons. One of which is:

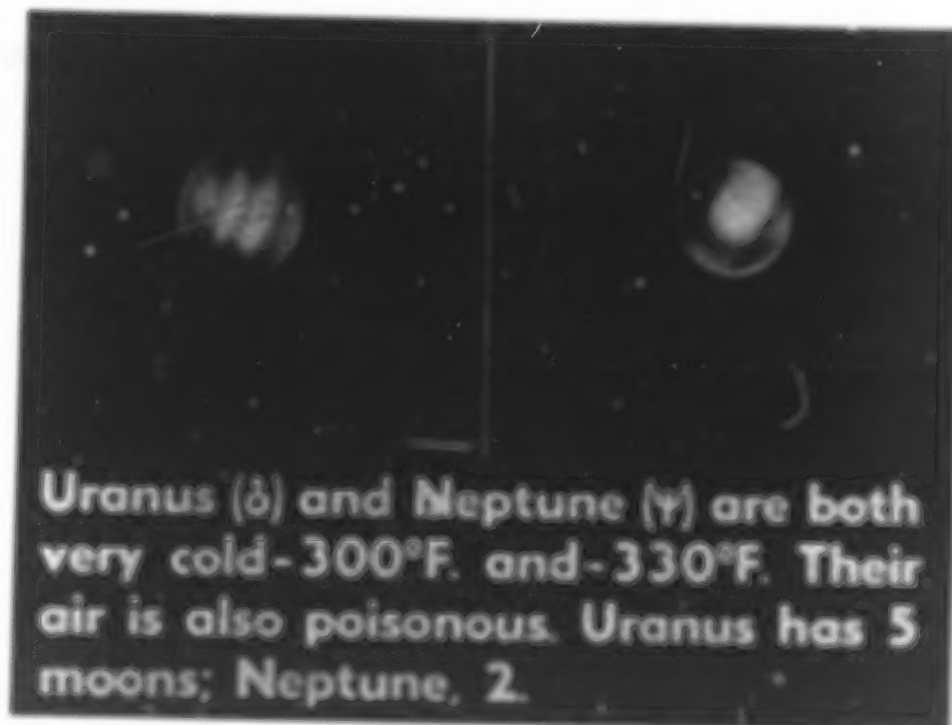
1. the high temperature
2. that it is extremely cold
3. large land areas are covered with ice
4. not enough water

Table 50 shows the responses to Test item 55.

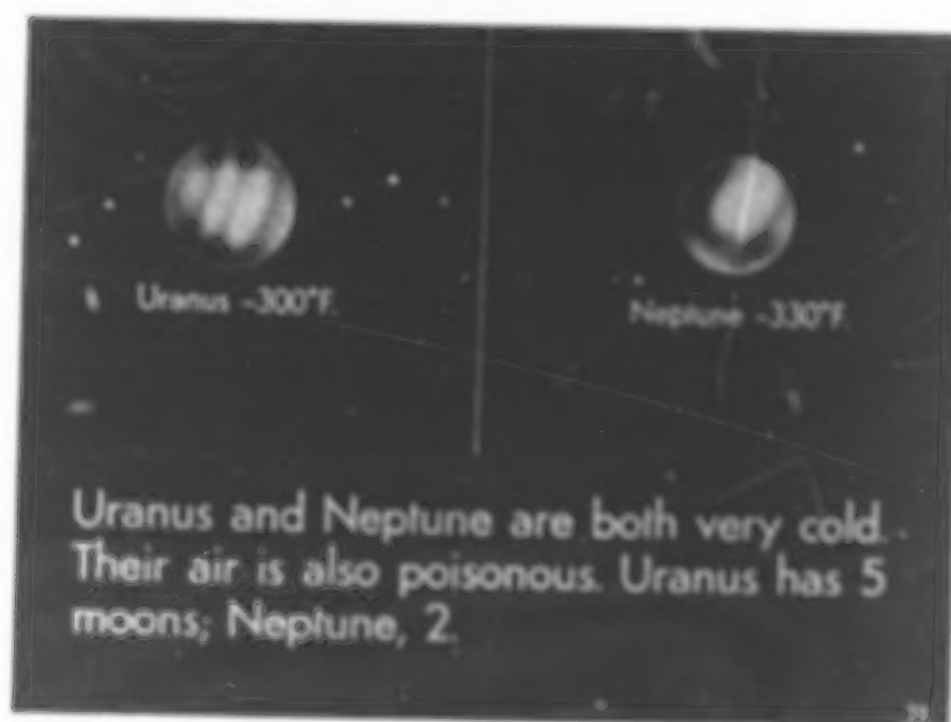
TABLE 50
Percent Choosing Various Responses to Item 55

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	15	10	10	15	7	8
2	35	37	37	54*	56	56
3	8	4	12	4	5	2
4	42	49	41	27	32	34

*Significant at the .05 level



Frame 39, Original



Frame 39, Revision

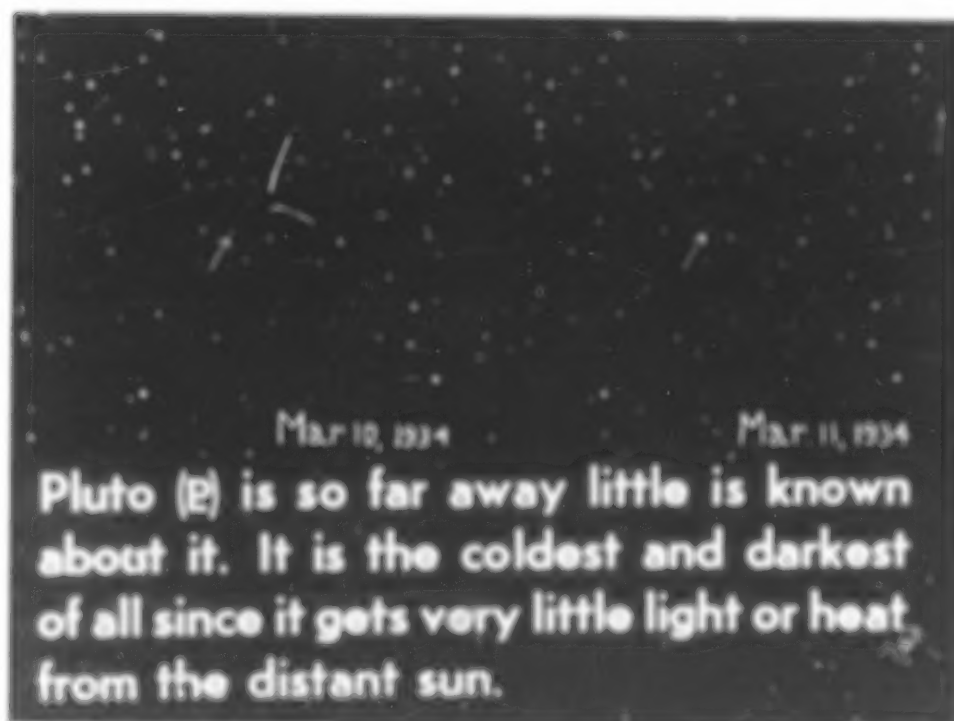
The single significant difference favored the revision at the five percent level of significance. Identical proportions of tenth graders seeing the original and the revision responded correctly to the test item, and virtually identical proportions of fifth and sixth graders did. It may be significant to note that more fifth and sixth graders seeing both versions and more seventh graders seeing the original chose to select the response that indicated that life on Neptune was impossible because of lack of water. This was the only response, other than the correct one, that was selected by a sizeable proportion of students at all grade levels.

The pictorial element of Frame 40 in the original film-strip is identical with that of Frame 32. The caption is changed, however. In the revision, a new frame was introduced which tried to visualize how the sun would appear as viewed from Pluto. The caption was changed accordingly. In the change of the caption, the description of Pluto was somewhat weakened in terms of the adjectives used. In the original Pluto was described as "the coldest and darkest" whereas in the revision it was described as "very cold and dark".

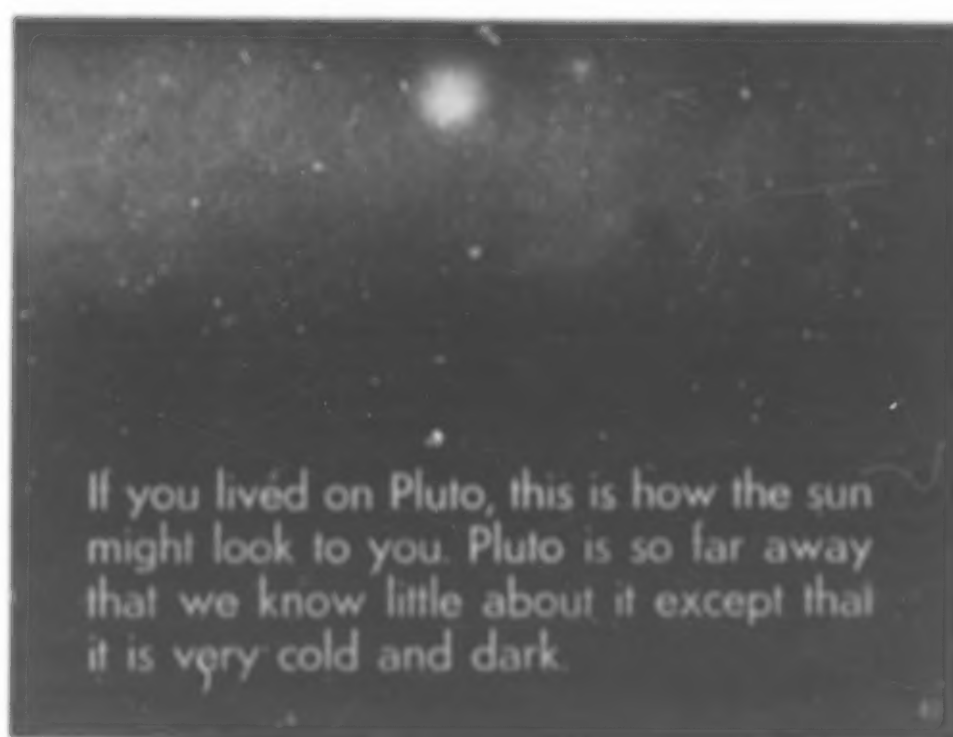
Test item 56 related to Frame 40.

56. If you could visit Pluto, the sun would appear to be

1. a very bright star
2. a huge, nearby fireball
3. one big glowing hot mass
4. an object the size of our moon



Frame 40, Original



Frame 40, Revision

Table 51 shows the responses to Test item 56.

TABLE 51
Percent Choosing Various Responses to Item 56

Choice	Grade 5-6		Grade 7		Grade 10	
	FSD	FRR	FSD	FRR	FSD	FRR
W	72	68	72	71	59	61
1	25	26	26	15	31	27
2	14	16	21	14	10	8
3	28	22	21	17	15	10
4	33	36	32	54*	44	55

*Significant at the .01 level

The correct response to Test item 56 is choice one. Table 1 shows that this was selected by approximately a chance proportion of students. Alternative four was selected by consistently the largest number of students, and at the seventh grade level proportion seeing the revision who selected the second choice was significantly greater than the proportion seeing the original. A glance at the revised frame would indicate that this result might have been expected in view of the fact that the artist's execution of the appearance of the sun from Pluto certainly closely approximates the appearance of the moon as seen from the earth.

Test item 57 requires the mastery of a general concept of the relationship between distance from the sun and temperature of planets. This information was presented by a number of separate frames.

57. Planets that are closest to the sun can be said to be

1. larger than distant planets
2. colder than distant planets
3. the same temperature as distant planets
4. warmer than distant planets

As can be seen from Table 52, proportions ranging from 70 to 92 responded correctly to Test item 57. There were no significant differences between groups seeing the original filmstrip and the revised filmstrip.

TABLE 52

Percent Choosing Various Responses to Item 57

Choice	Grade 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
1	7	7	4	11	5	0
2	11	14	1	8	7	5
3	8	9	3	1	0	5
4	74	70	92	79	88	90

RESULTS OF TOTAL FILMSTRIP SHOWING

As can be seen from Table 53, the fifth, sixth and seventh graders who saw the revised filmstrip achieved significantly higher mean test scores than those who saw the original filmstrip. There were no significant differences in mean test scores earned by the tenth grade groups. It must be conceded, however, that the differences found, though statistically significant, are not particularly impressive in absolute terms. The younger subjects who saw the revised filmstrips scored about four points higher than their counterparts on a fifty-seven item test, and the seventh graders scored a little more than two points higher. Converted to percentages these round out to about seven percent and four percent respectively.

The range of proportions passing various items extended from what could be considered virtually zero (25 percent or less choosing the correct response on a four choice multiple choice item) to virtually 100 percent.

It should be recalled in interpreting these test results, that the scores on the test represent what the students remembered from a single viewing of a filmstrip which was shown without comment a single time. Of course, the investigator's practice of reading the labels and captions out loud as part of the filmstrip presentation may have added something to the filmstrip, and it is not to be expected that the material covered was entirely new to all the students, even though they had not been taught the particular material covered by the filmstrip within the current academic year.

TABLE 53

Comparison of Groups Seeing Original and Revised
Versions of the Filmstrip Sun and Its Planets

	Grades 5-6		Grade 7		Grade 10	
	FSO	FSRR	FSO	FSRR	FSO	FSRR
N	72	68	72	71	59	61
Mean	27.80	31.96	33.47	35.83	38.12	37.82
Standard Error of Mean	.874	.856	.751	.831	1.017	1.183
Difference		4.16		2.36	.70	
Critical Rates		3.40*		2.11	N.S.	
Standard Deviation	7.42	7.06	6.37	7.00	7.81	9.24

*Significant at the .01 level
**Significant at the .05 level

Table 54 shows that twenty of the revised frames seemed to produce significant differences in proportions passing related test items. In some half dozen cases, no revision was attempted, and some of the revisions were not extensive. There were fifty-seven test items, and there were significant differences in proportions passing twenty-one of these test items. Generally, the test items were specific to a particular revision, but this was not true in all cases.

TABLE 54

Numbers of Frames and Test Items for Which
Revision Produced Significant Differences

	Test Items	Frames
Total in Test and Filmstrip	57	40
Number in which there was a significant difference of only one grade	11	11
Number in which there was a significant difference in only two grades	6	4
Number in which there was a significant difference in all three grades	4	5

Table 55 shows something of how the different grade levels of students reacted to the revision. Significant differences between groups seeing the revised and original versions were more frequently found among the younger students.

Tables 56 and 57 characterize the types of revisions in the pictorial element of the filmstrip frames and in the captions of the filmstrip frames, respectively. It will be observed that there are some twenty-one types of revisions in all.

The most common revision of the picture element was the addition of labels and/or attention directing arrows. This revision was not always successful in producing significantly greater proportions of students selecting the correct alternative on the appropriate test item, but it was successful more often than not. The addition of symbols such as dates to show relative motions of planets among the stars was successful in two out of three of the revisions in which it was attempted. In two frames, the revision consisted of making a progression of labeled objects or sequence of events proceed in the direction of normal reading; namely, from left to right or from top to bottom. These modifications were uniformly successful. Also uniformly successful and closely related was the organization of randomly presented non-verbal material into tabular form. This was attempted in three frames.

Two rather conspicuous failures were in the increase of iconicity where no significant differences resulted in two out of three cases, and in the increase of size of attention getting arrows or labels, in which three out of three revisions proved fruitless.

TABLE 55

Number of Items and Frames by Grade on Which Revision
Produced Significant Differences

	Grades 5-6		Grade 7		Grade 10	
	Original	Revision	Original	Revision	Original	Revision
Number of Items favoring	0	11	1	13	3	7
Number of Frame Revisions Favoring	0	11	1	13	2	7

TABLE 56

Types of Revisions of "Picture" Element of Frames

Addition of labels and/or attention direction arrows	Fr	<u>1*</u> , 10, 16 <u>22-23</u> 25 <u>27</u> 31 <u>32</u> 34 <u>35</u> <u>39</u>
	Items	<u>1-2</u> , 17, 25 <u>32</u> 37 <u>39</u> <u>40</u> 44 <u>45</u> 47 <u>48-49</u> <u>55</u>
Spread content over two frames	Fr	2
	Item	3
Make picture and caption agree	Fr	<u>3</u>
	Item	<u>4-5</u>
Added cues (like dates to show relative motion)	Fr	<u>5</u> <u>18-19</u> 26
	Item	<u>7-8-9</u> <u>28-29</u> 38
Place labels where there is no mistake as to what the label denotes	Fr	8 13
	Item	13, 22-23
Progression of labeled objects or sequence of events from L to R instead of R-L; or top to bottom instead of bottom to top	Fr	<u>9,10</u>
	Item	<u>14-16</u> , <u>17-18</u>
Reduce iconicity	Fr	11
	Item	20
Add reference point for size	Fr	11
	Item	20
Increase size of attention arrows or labels	Fr	12, 16 25
	Item	21, 25 37
Organize random material into tables	Fr	<u>13-14</u> <u>17</u>
	Item	<u>24</u> <u>26-27</u>
Increase Iconicity	Fr	20 34 <u>40</u>
	Item	30 47 <u>56</u>

*Items in which significant differences in proportions selecting crucial alternatives appeared are underlined.

Three types of revisions were relatively uniformly successful in improving captions. These changes are related but different. In the first place, capitalization or underlining key words or phrases seemed to produce significantly successful results in three out of four instances. In each of the three frames in which it was tried, furthermore, the addition of attention directing questions or statements proved successful. Perhaps the other side of the coin is the elimination of content that appeared to be irrelevant. There were eight captions modified in this way and in six cases the modification seemed to be related to a significantly higher proportion of students passing appropriate items.

Three caption modifications related to one or another aspect of readability. The use of the first person proved successful on the one occasion when it was tried, the use of a statement of principle instead of a statement of simple fact was likewise successful, as was the substitution of a simple sentence for complex sentences in at least half of the cases where this revision was made.

No particular brief can be held for the validity of the categories in which the revisions are grouped. They seem logical to the investigators, but the serious student of the improvement of filmstrips is encouraged to study the early portions of this chapter where reproduction of filmstrip frames and the original in a revised form can be studied in the context of the test items and of the students responses to these test items.

TABLE 57
Types of Revisions of Captions

Capitalize or underline key words or phrases	Fr <u>1</u> , 9, <u>13-14</u> <u>24</u> Item <u>2</u> , 15, <u>24</u> <u>35</u>
Spread content over two frames	Fr 2 Item 3
Eliminate irrelevant content	Fr <u>3</u> , <u>6</u> , 34 <u>35</u> <u>37</u> 38 <u>39</u> <u>40</u> Item <u>4</u> , <u>10</u> , 47 <u>48-49</u> <u>51-52</u> 53-54 <u>55</u> <u>56</u>
Use of first person	Fr <u>5</u> Item <u>8</u>
Add attention directing question or statement	Fr <u>6</u> <u>18-19</u> <u>32</u> Item <u>10</u> <u>28-29</u> <u>45</u>
Technical** accuracy	Fr 8 <u>17</u> 36 Item none <u>26,27</u> 50
Combine words and figures for large numbers	Fr 9, 10 Item 16, 18
Add cues	Fr 10 Item 20
Simple sentence instead of complex sentence	Fr 13 22-23 <u>35</u> <u>37</u> Item 22-23, 33-34 <u>48-49</u> <u>51-52</u>
State in form of a principle instead of a simple fact	Fr <u>13-14</u> Item <u>24</u>

*Items in which significant differences in proportions selecting crucial alternatives appeared are underlined.

** In some cases the original filmstrip gave information that was not correct, or subject to misinterpretation. The term "technical accuracy" denotes correcting such errors even when it was not directly tested.

Perhaps the one conclusion that can be drawn from the research reported herein is that it is possible to increase the teaching power of filmstrips through systematic testing and revision. In the process, some tentative hypotheses emerge which may be applied with profit to the original production of future filmstrips.

APPENDIX A

Instructions for Introducing
"The Sun and Its Planets",
delayed testing, Mt. Union, Pa.

I'm Mr. Montgomery from The Pennsylvania State University. You are being privileged to take part in a very important phase of filmstrip research. It is so important, in fact, that the U.S. Government is supporting the project with funds and is interested in the results.

Let me tell you more about what you can do to help. In a few minutes you will view a filmstrip entitled "The Sun and Its Planets". I will read the caption or printed sentences appearing on each frame. You should follow the reading silently and then study very carefully the pictorial material and printed material on each frame. You will have 15 seconds after I have read the caption to try to learn all you can from each frame. At the end of the filmstrip, you will be given a test. This test will show what you learned.

Now, please, pay very close attention and concentrate to the best of your ability.

(The filmstrip was shown and then the tests, IBM answer sheets, and electrographic pencils were passed to the students. Directions were explained to the students using the sample on the answer sheet. They were warned that response number five is never used since the test has only four distractors. Students were admonished to read all four distractors carefully before making a choice.)

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APPENDIX B

ACHIEVEMENT TEST

THE SUN AND ITS PLANETS

Captain Jack Area Schools, Mount Union, Pennsylvania

Delayed Testing. April 1961.

1. Which of the following lines has in it the name of something that is not in our solar system?

1. the sun, comets, meteors
2. planets, moons, asteroids
3. moons, constellations, the sun
4. asteroids, planets, meteors

2. The sun is a star. In what part of our solar system is it located?

1. northern part
2. southern part
3. center
4. outer part

3. The sun is a huge globe of

1. solid coal that will burn forever
2. earth covered with hot lava
3. rock polished like nickel
4. glowing hot gases

4. How many earths side by side would it take to equal the diameter of the sun?

1. 50
2. 108
3. 866,000
4. 1,300,000

5. Which pairs show the relative size of the sun and earth?

1. Earth 	Sun 	2. Earth 	Sun 
3. Earth 	Sun 	4. Earth 	Sun 

6. The sun gives light and heat. This heat comes from
 1. the reflected heat from the stars
 2. nuclear or atomic energy
 3. fires burning on the surface
 4. molten lava on the surface
7. The sun turns on its axis once
 1. each day
 2. every $10\frac{1}{2}$ days
 3. every $24\frac{1}{2}$ days
 4. each year
8. We can tell that the sun turns on its axis because of
 1. the changing position of sun spots
 2. the difference in cloud formations
 3. its effect on the earth's orbit
 4. all of these
9. A scientist looks at the sun through a telescope and sees spots on the left side of the disk. Where will these spots be 12 days later?
 1. in the same place
 2. on the right side
 3. in the center
 4. toward the top
10. The whole solar system moves through space at a speed of
 1. 12 miles per second
 2. 32 miles per second
 3. 52 miles per second
 4. 62 miles per second
11. The planets revolve around the sun in nearly circular paths called
 1. positions
 2. rotations
 3. revolutions
 4. orbits

12. At night we can see some of the planets shining in the sky. These planets shine because of

1. the glare of the polar caps
2. light reflected from the planet's moons
3. fire on the surface of the planet
4. the reflected light of the sun

13. In comparing the sun to the planets in our solar system in size, which of the following is correct?

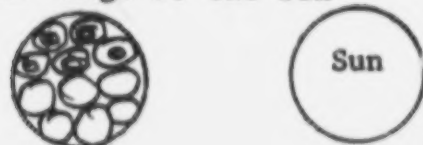
1. some planets are larger than the sun



2. Jupiter, by itself, is as large as the sun



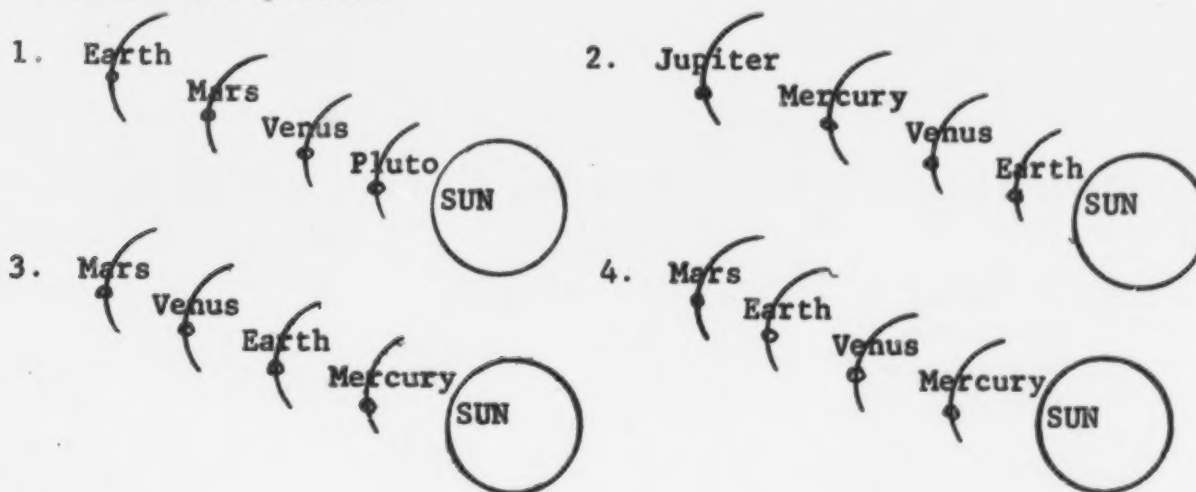
3. All the planets together are as large as the sun



4. All the planets would fit in a small corner of the sun



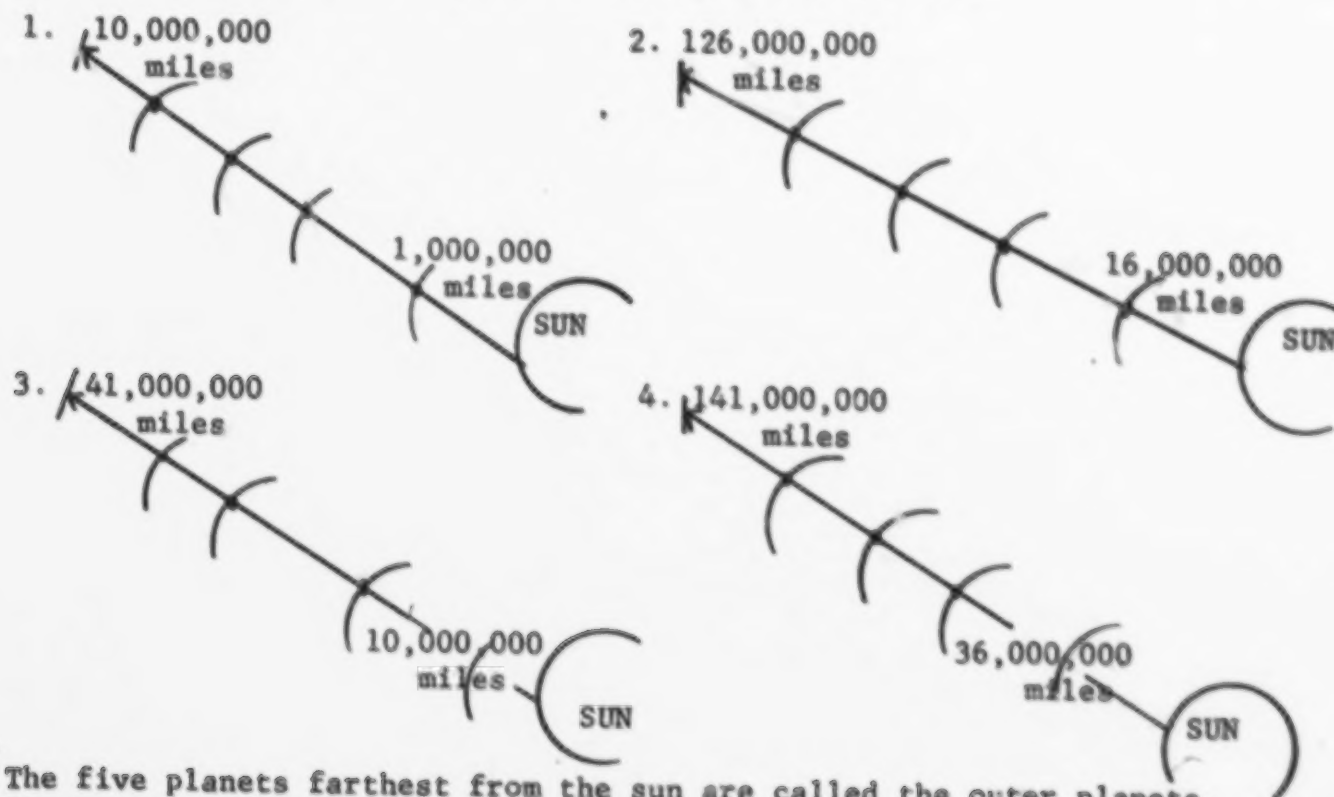
14. The four planets nearest the sun are called the inner planets. We call these planets:



15. The sizes of the inner planets are

1. about the same as the outer planets
2. all quite large
3. all quite small
4. unknown

16. In distance from the sun, the inner planets range from



17. The five planets farthest from the sun are called the outer planets. By name we call these planets:

1. Saturn, Uranus, Neptune, Pluto, Mars
2. Earth, Jupiter, Uranus, Neptune, Pluto
3. Jupiter, Saturn, Uranus, Neptune, Pluto
4. Neptune, Uranus, Saturn, Jupiter, Earth

18. In distance from the sun, the outer planets range from:

1. 80 to 210 million miles
2. 450 to 900 million miles
3. 480 to 3,665 million miles
4. 540 to 7,671 million miles

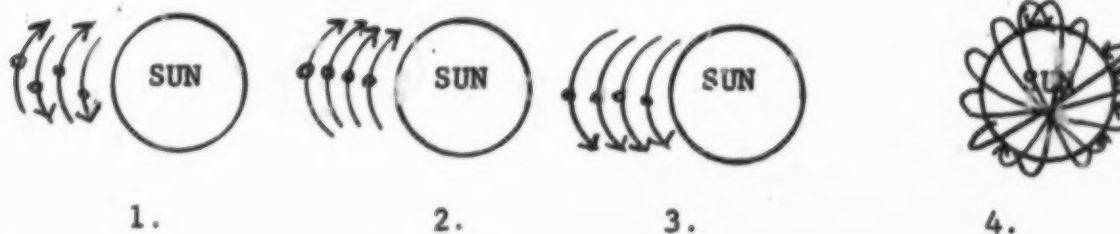
19. In all but one of the following pairs the larger planet is listed first. Choose this pair.

1. Neptune, Pluto
2. Earth, Venus
3. Jupiter, Saturn
4. Mars, Mercury

20. The largest planets in our solar system are:

1. Neptune, Jupiter
2. Saturn, Pluto
3. Uranus, Neptune
4. Jupiter, Saturn

21. Which diagram shows the correct movement of planets around the sun?



22. What is a year in terms of each planet in the solar system?

1. The time it takes to make one-half of a revolution
2. The time it takes to go around the sun
3. The time it takes to turn on its axis
4. The speed of rotation

23. Which planets have the same length year?

1. Earth and Mars
2. Mars and Pluto
3. Mercury and Pluto
4. None have the same

24. Imagine that an astronomer discovered two new planets, one beyond Pluto and the other near Mercury. Which of the following statements would be most likely to be correct?

1. The planet beyond Pluto would have to take more than a hundred years to go around the sun.
2. The planet beyond Pluto would travel about 5 miles per second.
3. The planet near Mercury would go around the sun in about 10 months.
4. The planet near Mercury would travel about 5 miles per second.

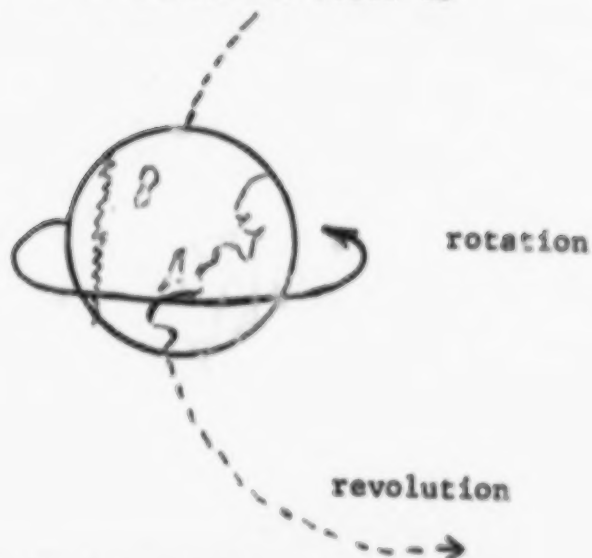
25. Refer to the diagram at the right. Which statement below is correct?

1. The words revolution and rotation should be interchanged

2. The arrow along side of revolution should point the other way

3. The side nearest the word rotation is in daylight

4. The side opposite the word rotation is in daylight



26. Not all the rotation periods of the planets are known. Which two are unknown:

1. Mercury and Uranus

2. Venus and Pluto

3. Jupiter and Saturn

4. Neptune and Mars

27. Which planet has the shortest rotation period?

1. Jupiter

2. Mercury

3. Uranus

4. Earth

28. How can you tell the difference between a planet and a star?

1. stars are in the same relative position every night

2. stars have a slightly different color

3. stars become brighter during a full moon

4. stars are brighter than planets

29. At 9 P.M. on March 1, you see the planet Jupiter as you face straight south. If you look again on April 1 at the same time, where will you see Jupiter?

1. at exactly the same place where you saw it before

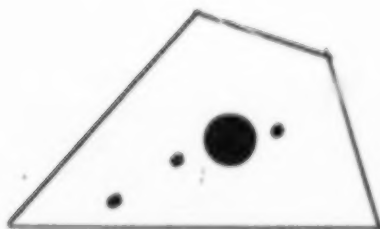
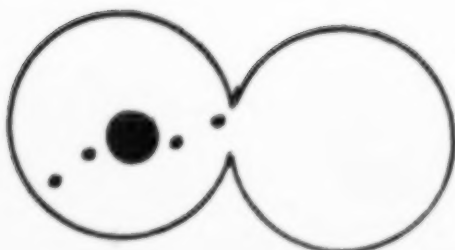
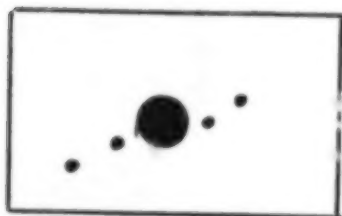
2. closer to the western horizon than where you first saw it

3. to the left of where you first saw it

4. to the right of where you first saw it

30. Mercury and Venus are seen only near the sun either at dawn or at sunset because:
1. they are too dim
 2. at that time they are not hidden by clouds
 3. they are moving too fast
 4. they are between the sun and earth
31. When "West" of the sun Mercury and Venus rise before the sun and are seen as:
1. evening "stars"
 2. moons
 3. morning "stars"
 4. comets
32. As they appear to cross the earth's sky,
1. all planets follow the same path as the moon and sun
 2. all planets follow somewhat different paths
 3. all planets follow the same path, but a different one from that followed by the sun and moon
 4. some planets follow one path and some follow another
33. At night Uranus, Neptune, and Pluto can be seen:
1. by the bare eye
 2. by looking thru colored glass
 3. only with a telescope
 4. not at all
34. Which of the following planets can be seen without the aid of a telescope?
1. Uranus
 2. Mercury
 3. Neptune
 4. Pluto
35. To study the planets a telescope may be used
1. only to brighten the planet images
 2. only to magnify the planet images
 3. to brighten and magnify planet images
 4. to filter out haze and dust that dims planet images

36. Which is most like what you would see if you looked at Jupiter through a telescope?



37. From earth we can see Mercury as it passes across the face of the sun. Which drawing most nearly represents this?



1.



2.



3.



4.

38. Mercury, like Venus, shows phases like our moon. The reason for this is because the positions of the earth, sun and Mercury are like one of the figures shown below. Which one:

Mercury ○ Earth ○ Sun ○ Venus ○ 1.	Venus ○ Mercury ○ Sun ○ Earth ○ 2.	Venus ○ Sun ○ Mercury ○ Earth ○ 3.	Earth ○ Sun ○ Venus ○ Mercury ○ 4.
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39. Do you remember seeing a picture of Mars in the filmstrip? What outstanding features do you remember:



40. In the filmstrip Mars was shown to have an important characteristic structure. What was it?

1. no vegetation
2. clouds bands
3. polar icecap
4. no desert area

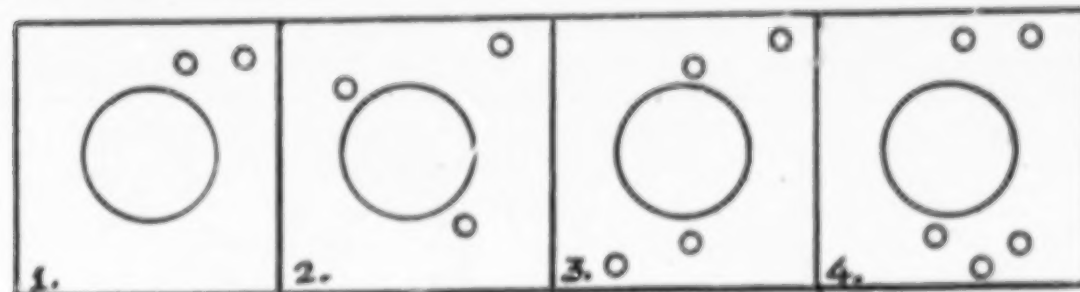
41. A very clear picture of Jupiter was also shown. Choose the picture which most closely reminds you of the filmstrip:



42. Select from the four drawings below the picture that most closely resembles the picture of Saturn:



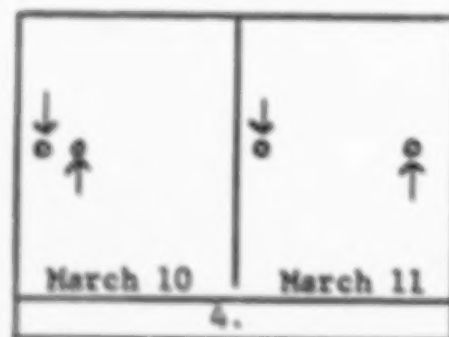
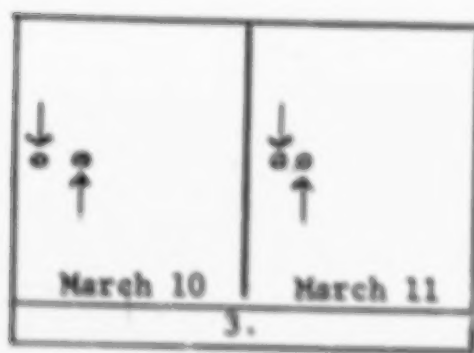
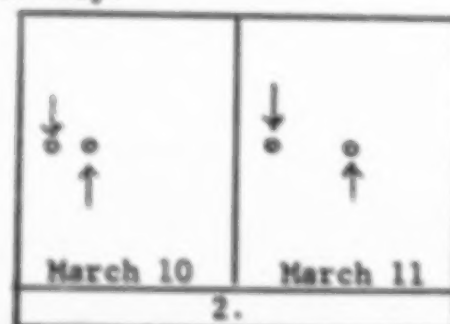
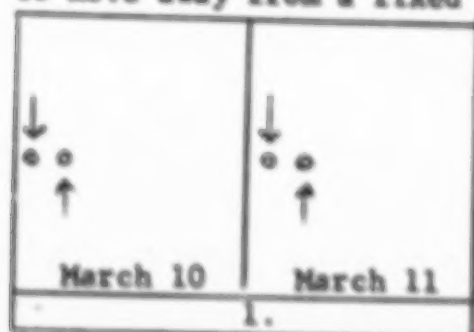
43. In the four pictures of Uranus below choose the one with the correct number of moons



44. Neptune was found

1. when its shadow hid Pluto from our microscopes
2. when it was discovered something was disturbing the orbit of Uranus
3. when it passed to the right of the sun 113 years ago
4. by telescope after its location was mathematically predicted

45. Which shows most accurately the extent to which Pluto appears to move away from a fixed star in one day?



46. Which of the following temperatures is the coldest?

1. 600°F
2. 32°F
3. 0°F
4. -459°F

47. Venus is completely covered by clouds, and so very little is known about it. We do know that it

1. has snow-covered mountains
2. is the fastest moving planet of the inner planets
3. is larger than our earth
4. is the brightest of the planets

48. We know that Mars is

1. completely covered with ice
2. very hot during the day
3. mostly desert with some vegetation
4. nothing but red sand

49. We know that Mars is

1. colder than the earth in winter but warmer in summer
2. warmer than the earth at the equator but colder at the poles
3. colder than earth at night but warmer during the day
4. always colder than the earth

50. Markings can be seen on Mars. They are

1. probably strips of vegetation
2. canals made by intelligent beings
3. of unknown origin
4. optical illusions

51. We know that the atmosphere on Jupiter is composed of

1. poisonous carbon monoxide and ethane gas
2. poisonous ammonia and methane gas
3. poisonous carbon dioxide and ammonia
4. hydrogen and poisonous methane gas

52. How many moons does Jupiter have?

1. four moons
2. nine moons
3. twelve moons
4. fifteen moons

53. It is easy to remember the number of moons circling Saturn because it is the same number as

1. the moons of Mars
2. the planets in our solar system
3. the moons of Jupiter
4. the moons of Mercury

54. Saturn has how many moons?
1. two
 2. four
 3. five
 4. nine
55. Life on Uranus and Neptune would be impossible for several reasons. One of which is:
1. the high temperature
 2. that it is extremely cold
 3. large land areas are covered with ice
 4. not enough water
56. If you could visit Pluto, the sun would appear to be
1. a very bright star
 2. a huge, nearby fireball
 3. one big glowing hot mass
 4. an object the size of our moon
57. Planets that are closer to the sun can be said to be
1. larger than distant planets
 2. colder than distant planets
 3. the same temperature as distant planets
 4. warmer than distant planets